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THE END OF THE **ENDOSYMBIOSIS THEORY?**

EARLY NOAH'S FLOOD YEAR: **GEOCHEMICAL AND RELATED EVIDENCE**

DRY VALLEYS of Jurassic Coast, England: PERIGLACIATION or NOAH'S FLOOD?

NEANDERTALS BECOMING **MORE MODERN WITH TIME**

THE SEARCH FOR ADAM, EVE, AND **CREATION IN ANCIENT EGYPT**

JOURNAL OF CREATION

An international journal devoted to the presentation and discussion of technical aspects of the sciences such as geology, biology, astronomy, etc., and also geography, archaeology, biblical history, philosophy, etc., as they relate to the study of biblical creation and Noah's Flood.

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PERSPECTIVES

Phoenicoid fungi following the eruption of Mount St Helens may provide insight into ecological responses that occurred after Noah's Flood.

BOOK REVIEWS

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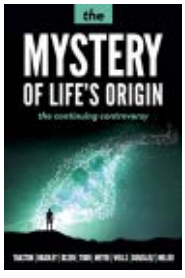
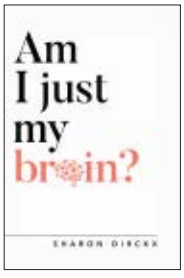
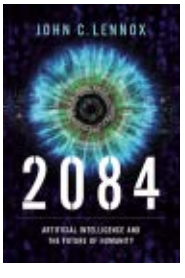
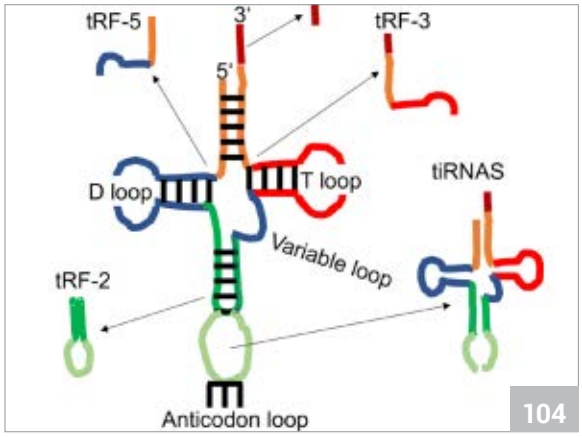
ESSAYS









Without the necessary protein-based molecular machines, the correct amount of the right kinds of tRNAs under the correct circumstances cannot be regulated.

Molecular studies of megabats and microbats indicate that the bat baramin can be considered as a superfamily.

VIEWPOINT

PAPERS

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Phoenicoid fungi: first responders at Mount St Helens

Keith H. Swenson

On 28 May 1980, just 10 days after the cataclysmic eruption of Mount St Helens in the state of Washington, USA, geomorphologist Fred Swanson was digging 'little holes' in the newly emplaced debris avalanche deposit.[1,2] Located immediately north of the volcano, the deposit consisted of landslide material from the collapse of the summit and north slope of Mount St Helens, covered by pumice fragments from the subsequent nine-hour eruption. As he worked, Swanson noticed something that puzzled him. Extending from the wall of one of the holes and fluttering in the breezes were barely visible spiderweb-like filaments, to which tiny ash particles had adhered. Swanson did not understand what he was seeing, but later learned the filaments were hyphae[3] (figure 1) of so-called 'burn-site', 'fire', or 'pyrophilous' fungi.[4] These organisms are known to persist for decades and only produce fruiting bodies ('mushrooms') after the heat[5] of a fire[6]—or in this case, a volcanic eruption. Swanson dubbed them 'the first biological response' to the eruption.[7] And since fire was not the heat source, mycologists Steven E. Carpenter and James M. Trappe later coined a more general term 'phoenicoid fungi', after the mythical Phoenix bird (which arises from ashes),[8,9] for "fungi that pioneer on heat-treated substrates".[10]

Post-eruption fungi

During his initial mycological foray into the blast zone on 1 July 1980, Carpenter observed white patches of fungus growing in moist depressions on tephra[11] deposits and in areas shaded by fallen trees.[12,13] He identified this first observed fungal colonizer as *Anthracobia melaloma* (figure 2), a well-known phoenicoid fungus associated with forest fires. In addition, within some of the fungal colonies were algal filaments and the earliest stages of moss growth. Notably, these initial photosynthetic organisms were found only in association with *A. melaloma* colonies, not on barren pumice deposits. Over the ensuing months, numerous other species of phoenicoid fungi appeared, both as mycelial[3] mats and as fruiting bodies. Within these fungal patches, algae, bryophytes (mosses), and vascular plants subsequently established, forming small oases of plant recovery within the pumice desert.

Remarkably, the pattern of fungal responses observed at Mount St Helens was similar to post-fire fungal behaviour in other parts of the world.[6] For example, *Anthrocobia* species generally appear soon after a thermal stimulus, to be followed by multiple other ascomycete[14] species and months later by basidiomycetes.[15] Claridge *et al* comment:

> "… postfire fungal phenomenon [sic] occur similarly halfway around the world in forest types as dissimilar as Pacific Northwestern conifers and south-eastern Australian eucalypts"[6]
>
> and
>
> "The parallels between the fires in these far removed and markedly different forests were striking, as was the similar mycological aftermath of the Mount St Helens eruption."[6]

Ecological roles

The early arrival of phoenicoid fungi played several pivotal roles in "laying the ecological foundation for a new ecosystem"[7] following the 1980 eruption of Mount St Helens. Listed below are processes attributed to phoenicoid fungi based on observations at Mount St Helens and other sites. They:

1. Stabilized substrates

Immediately following their emplacement, loose deposits of tephra

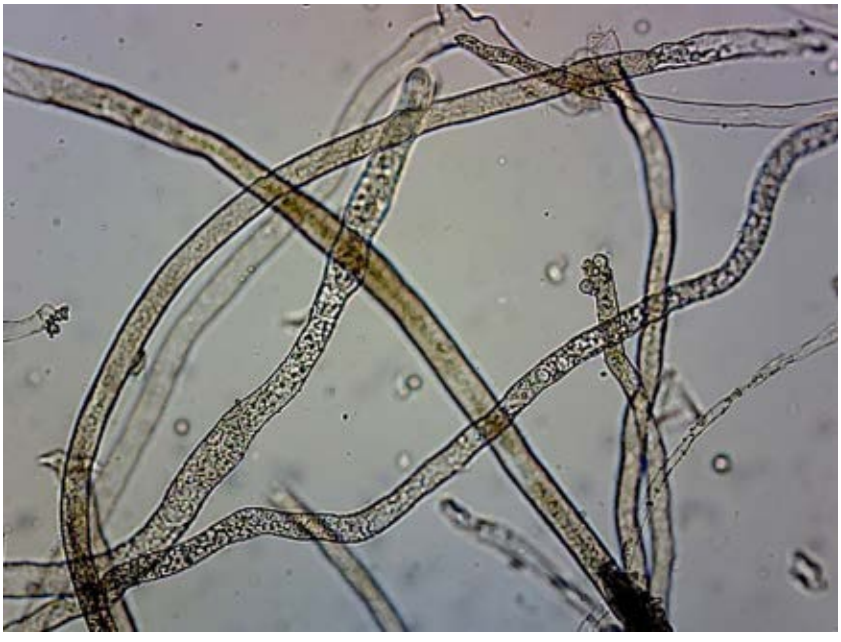

Figure 1. Within 10 days following the eruption of Mount St Helens, fungal hyphae (similar to those shown here) had already penetrated and were helping to stabilize pumice deposits on the debris avalanche.

were highly erodible, lacking the stability needed for plant recovery. The rapid growth of fungal hyphae within these deposits acted like living, microscopic rebar, stabilizing substrates. Claridge *et al*. summarize:

> "We hypothesise that fungi such as *Anthracobia* are pivotal species in early system recovery after disturbance, helping minimize the movement of soil in the absence of plant roots."[16]

2. Increased aeration and water infiltration

In addition to stabilizing post-eruption substrates, fungal hyphae aggregated small particles of tephra, forming pore spaces, which facilitated the entry of air and water into developing soils, benefiting plants. Claridge *et al*. state concerning postfire fungi: "Mycelial networks bind soil particles into aggregates, thereby improving aeration and water infiltration."[6,17]

3. Decomposed organic materials

Much organic material was incorporated into the lateral blast as it penetrated the forest north of Mount St Helens.[18] Soil, leaves, coarse woody debris, and animal remains permeated the resulting nutrient-deficient volcanic deposits.[19] Subsequent decomposition of these organics by phoenicoid fungi released organically bound nitrogen, phosphorus, and other nutrients, creating a substrate more suitable for plant colonization than loose tephra.

Claridge *et al*. illustrate the critical need for nutrient acquisition by fresh volcanic substrates with the following discovery, which occurred about a year after the eruption:

> "Fluids from the decaying remains of a horse killed by the eruption had seeped down slope. The seepage zone was a lush garden of bryophytes and fungal fruiting bodies set amidst the gray, non-vegetated tephra otherwise blanketing that site."[18]

4. Sequestered nutrients

Nutrients released into volcanic deposits by fungal decomposition of organic materials were then taken up and sequestered by additional fungi, algae, mosses, and vascular plants. Subsequent decomposition of these organisms released more nutrients, further enriching developing soils.

5. Produced organic platforms for photosynthesizers

Sites where hyphal mats and masses of fruiting bodies of phoenicoid fungi had stabilized and enriched pumice substrates became prime locations for early colonization by photosynthesizers, including algae, mosses, and vascular plants. Carpenter *et al*. state: "The phoenicoid fungi on tephra in the devastation zone clearly prepared microsites for the growth of photosynthesizers"[20] and "were clearly crucial in releasing nutrients from organic matter in the tephra for uptake by algae and bryophytes."[21]

6. Likely formed symbiotic relationships with plants

Most forest plants in the Pacific Northwest (and elsewhere) form symbiotic associations with fungi, including phoenicoid species. Such relationships may be mycorrhizal, endophytic, or parasitic (pathogenic). Claridge *et al*., referring to phoenicoid fungi, state: "still others appear to be mycorrhizal symbionts with or pathogens on tree roots."[6]

Mycorrhizal fungi are soil organisms that form mutualistic symbioses with plant roots. The fungal symbionts benefit from this association by receiving photosynthesized carbon compounds from the plants. In turn, fungal symbionts act as extenders of plant roots bringing soil nutrients (including phosphorous, magnesium, iron) and water to their host plants. The importance of mycorrhizae cannot be overemphasized. Allen states: "Mycorrhizae can be formed between nearly all phyla of fungi and almost all land plants, with only a few exceptions."[22] At Mount St Helens, all forest tree species are dependent on fungal associations for normal growth and development.

Endophytic fungi, some of which are phoenicoids, are plant symbionts that reside within plant tissue and even within plant cells. The association is often mutualistic in that the fungal

Figure 2. *Anthracobia melaloma* was the initial phoenicoid fungus identified following the eruption of Mount St Helens. It occurred both as white mycelial patches and orange fruiting bodies. Shown here are fruiting bodies seen after a forest fire in California.

symbionts receive carbon compounds from their host plants, which in turn are defended against arthropod herbivores by chemicals produced by the fungi.[23] For example, the dominant conifer tree of many forests in north-western North America is the Douglas fir (*Pseudotsuga menziesii*). Its needles are inhabited by several species of fungi capable of mounting chemical attacks on species of defoliating insects.[24]

Some fungi associated with plant roots, as well as certain endophytic fungi, are parasites or pathogens of plants. Although detrimental to their host plants, they help control the growth and spread of plant populations, preventing species from becoming invasive.

7. Provided a food source for animals

Although not well-documented in the literature, phoenicoid fungi likely served as an important food source for colonizing fungivorous insects and small mammals.

Implications

In ecology, a 'disturbance' is any process that disrupts an ecosystem, such as fire, hurricane, landslide, or volcanic eruption. Immediately following such a disturbance, a suite of processes called 'succession' (or in lay terms, 'recovery') is initiated. It appears that ecosystems are well-designed by their Creator to respond effectively to disturbances, even catastrophic ones. Such a remarkable ability to bounce back is a clear indication of design in ecosystems, just as there is design in cells, organs, and organisms. The rapid response of phoenicoid fungi to fire or volcanic eruption provides good evidence of the Creator's forethought.

Phoenicoid fungi also provide insight into ecological responses that occurred following Noah's Flood. Certainly, propagules of phoenicoid fungi survived the Flood in the atmosphere, the floodwaters, on floating vegetation mats, and in sediments. Post-Flood volcanic eruptions, hydrothermal processes, and fires would have provided heat sources. Similarities between heat-induced fungal responses in diverse parts of the world today suggest these responses are normative following fire or volcanic events. It is reasonable, therefore, to hypothesize that activities involving phoenicoid fungi, similar to those documented at Mount St Helens, occurred globally on heat-affected substrates in the aftermath of Noah's Flood.

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3. 'Hyphae' are fungal filaments, composed of cell material, that make up the body of a fungus; a network of hyphae is termed a 'mycelium'.
4. Propagules (spores and fungal fragments) of this fungus were likely transported to the debris avalanche deposit by turbulent winds associated with the lateral blast of the volcano, which ripped up and incorporated forest soil and vegetation. Propagules could also have survived in the debris avalanche itself, which was buried beneath the pumice deposits.
5. Besides heat, other factors may be involved in triggering germination of phoenicoid propagules, such as changes in pH and chemistry of the substrate, and loss of a nutritionally associated host plant.
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10. Carpenter and Trappe, ref. 8, p. 203.
11. Tephra is fragmented (pyroclastic) material erupted into the air from a volcano.
12. Carpenter *et al*., ref. 9, p. 718.
13. Geologists reported seeing white fungal patches (presumably *A. melaloma*) as early as June 12, 1980 (ref. 12).
14. Ascomycetes (also called 'sac fungi') are members of the fungal phylum (division) Ascomycota, which contains over 64,000 species. It is named after the 'ascus', a microscopic structure in which spores are formed. Examples include *Anthracobia*, morels, cup fungi, and some truffles.
15. Basidiomycetes (also called 'club fungi') are members of the fungal phylum (division) Basidiomycota, which contains over 31,000 species. It is named after the 'basidium', a microscopic structure in which spores are formed. Examples include typical mushrooms, puffballs, and bracket fungi.
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The Putangirua Pinnacles: testament to the Flood account

Joshua Hawkes

The Putangirua Pinnacles are located on the south-east coast of the North Island of New Zealand, in the Wairarapa region. They are named 'pinnacles' because the process which has eroded them has produced a large number of rock towers of varying sizes, shown in figures 1 and 2. According to a *Dominion Post* article, "some resemble slender posts, others are fat and squat with a mop of vegetation on top, while still others are incorporated into great walls of stones, like the ribs of some ancient fossilised creature".[1] Some of the pinnacles are up to 60 m in height. The Pinnacles were used by Director Peter Jackson in *The Lord of the Rings: The Return of the King* for shooting the scene along the Dimholt Road, i.e. The Paths of the Dead.[1] The landscape attracts many visitors to the region and is a unique environment.

Limited data constraining the stratigraphic age is found in the secular literature,[2] and it appears the explanation is based on a uniformitarian assumption rather than any data. When comparing the uniformitarian model with flood mechanisms and stages such as those published by Walker[3] and Oard[4] the biblical framework provides a better explanation for their formation and exhumation, as well as providing tentative dates for their stratigraphic age.

Geologic setting and uniformitarian explanation

There are widely varying opinions on the deposition of the sediments which make up the pinnacles. According to publicly available sources the gravels which make up the pinnacles were deposited about 7–9 million years ago.[5] However, Bertaud-Gandar *et al.* note: "the age is not well constrained", and they assume the sediments are 10–12 million years old based upon the age of overlying formations. According to the formal Geological and Nuclear Sciences definition, the conglomerate forms part of the Palliser and Soren groups, which comprise "massive, or interbedded, mudstone, siltstone and sandstone with minor conglomerate, limestone and tuff".[6] According to Leach:

> "The coastal platform of Palliser Bay is a narrow unstable strip about 200 m wide, with only occasional outcrops of the rocky basement. The sediments are largely redeposited gravels from the Aorangi mountains. They have been produced by massive erosion processes which characterize the area and have been thrown up against the cliffs and foothills. In the Putangirua, Pinnacles, and Hurupi area, the sediments are of marine Miocene origin."[7]

The clasts contained in the gravel are very coarse, and range up to cobble and boulder sizes. The material is soft and can be easily broken up by hand

Figure 1. View of Putangirua Pinnacles from Putangirua Stream bed showing sharp relief

Figure 2. Further view of Pinnacles and large scale collapse of Pinnacles in distance

with little force required. Additionally, the faces of the pinnacles are steep and, as shown in figures 1 and 2, form very sharp edges.

The uniformitarian (and publicly broadcast) explanation for the formation of the Pinnacles relief varies widely. For instance, an article in the *Christchurch Press* stated the Pinnacles were "carved into enormous pipe-shaped towers over the last six to nine million years by heavy rainfall and running water".[8] Other sources such as the *Te Ara Encyclopedia of New Zealand* website state that they are at a minimum 1,000 years old,[9] but an actual date is not given. Thus, it appears there is no definitive date for their formation.

Uniformitarian explanation falls short

When examining the public and published material on the Pinnacles in terms of their deposition and their formation, it is easy to see there are several ways in which the uniformitarian explanation falls short. They include:

1. As stated earlier, nowhere is a basis provided for the 'date' of the gravels. This is just assumed, and it appears this is done purely based on the accepted secular geologic history of New Zealand and the Wairarapa region. There is no independent evidence from the rocks that they are this old.
2. According to the secular history, this area was laid down as marine gravels from the Aorangi mountains. These have been uplifted and exposed sometime between the time of their deposition and today. However, since the assumed time of the deposition there have been several cycles of sea level rise and fall: "During the Pleistocene the alternate locking up of vast quantities of sea water to form ice caps, followed by its release in interglacial episodes, caused sea level to rise and fall hundreds of feet all over the world."[10] Hence, to expect that these gravels, which have been exposed and inundated and re-exposed to the elements, have lasted over that time period is highly implausible.[11]
3. The shape and sharp relief of the pinnacles themselves testify to their rapid exhumation and of the massive amount of water required to carve their shapes in a very short period of time. A long period of exhumation and coastal erosion over long geological timescales would have disintegrated all the soft and friable material and removed all of these structures.

Figure 3. Fine-scale laminations and graveyard of shells in exposed bedrock underlying the pinnacles, indicating catastrophic deposition

Flood geology provides the answer

An origin based upon creationist literature provides a much more satisfactory answer to the question of the Putangirua Pinnacle's formation. Within the Flood geology model proposed by Walker[12] the formation of the gravels would have occurred during the mid-Recessive phase of the Flood, as run-off of the Aorangi mountains to the north and east of the Pinnacles. Observations of the bedrock underlying the gravel support this. It features large-scale deposition of marine fossils, and fine-scale laminations (figure 3). As the floodwaters receded off the uplifting land mass, the pinnacle channels were rapidly eroded. This indicates the Pinnacles were formed only thousands of years ago, consistent with the publicly available information. Following their exhumation and exposure they have assumed largely their present configuration, with occasional storm events causing some pinnacles to fail catastrophically. Indeed, evidence of this is readily apparent in the Scenic Reserve, particularly at the northern end of the riverbed, where catastrophic failure has led to some pinnacles resting on top of each other.

This explanation would also fit with the sharp relief, which would still be present after only thousands of years,

and the friable nature of the pinnacle material, which could only maintain the sharp features within a biblical timescale.

Conclusion

The Putangirua Pinnacles are not explicable according to secular geologic timescales and the principle of uniformitarianism. To expect that the material making up the Pinnacles has survived exhumation, storm events, re-inundation, and re-exhumation is a leap in logic and another example of evolutionary storytelling. The explanation of how the 'Hoodoos'[1] (so named by locals) came to be in their present condition is not a mystery to creationists, who have a satisfactory and elegant solution. The Putangirua Pinnacles show the reality of the Flood account, bring glory to God's word, and bring glory to Jesus Christ. When visitors and sightseers stand amongst the Putangirua Pinnacles the only logical response should be to quote the Psalmist who declared: "I will lift up mine eyes unto the hills, from whence cometh my help. My help cometh from the Lord, which made heaven and earth" (Psalm 121:1–2). However, as with many other sites across the world Satan has provided a lie which fails to adequately explain the formation of the Pinnacles, and allows people to worship the creature, rather than the Creator (Romans 1:25).

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The fossil record is complete enough

Michael J. Oard

Ever since Darwin wrote the *Origin of the Species*, evolutionists have regarded the fossil record as vastly incomplete. The fossil record is the actual record of past life in which evolution should be obvious. Darwin believed that the fossil record should be full of transitional fossils and blamed the lack of such fossils on the extreme imperfection of the fossil record:

> "But just in proportion as this process of extermination has acted on an enormous scale, so must the number of intermediate varieties, which have formerly existed, be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely-graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory. The explanation lies, as I believe, in the extreme imperfection of the geological record."[1]

Numerous secular scientists after Darwin have continued to use this excuse that the fossil record is vastly incomplete. For instance, renowned evolutionist, Stephen Jay Gould, wrote:

> "All paleontologists know that the fossil record contains precious little in the way of intermediate forms; transitions between major groups are characteristically abrupt. Gradualists usually extract themselves from this dilemma by invoking the extreme imperfection of the fossil record."[2]

Most scientists have heard of the imperfection of the fossil record, and paleontologists,

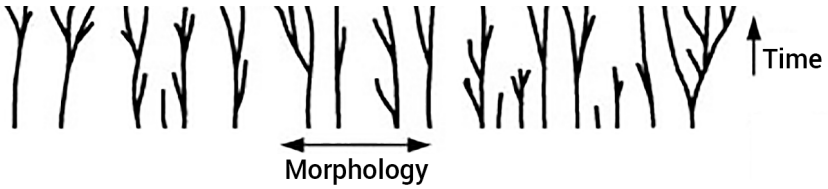

Figure 1. The creation orchard of life

> "… have underscored and emphasized Darwin's point for the past 150 years by routinely highlighting incompleteness and bias. And if bias was not good enough at scaring off the biologists, we have added megabias."[3]

The fossil record is essentially complete

Scientists have had more than 160 more years to collect fossils. Evolution should be obvious within the fossil record by now. Steven Holland points out that the fossil record is imperfect in a sense, but really nearly complete. It is imperfect in that it did not record every organism that has ever lived. So, "all data sets are incomplete",[3] and he believes we need to "take a different path."[3]

First of all, we need to recognize that the imperfection of the fossil record is exaggerated:

> "Our exaggerated emphasis on the imperfection of the fossil record feeds the perception among scientists in general that the fossil record is an unusually poor data set. It isn't. … We already know much about the structure of the fossil record."[4]

Holland recommends that paleontologists should not emphasize the incompleteness of the fossil record any more, although not ignoring it completely.

Second, Holland contends that instead of concluding as many do that the fossil record is not worth considering, scientists should 'embrace' it along with the sedimentary record, and work with it. The fossil record is better than most scientists recognize, since: "We know much about the structure of the fossil record."[5] Not only do paleontologists know the structure of the fossil record, but also that it provides a good record of species richness:

> "Through her comprehensive examinations of live-dead comparisons, Susan Kidwell (2002, 2013) showed the fossil record contains a high-fidelity record of species richness and especially abundance, a pattern both unexpected and most welcome."[5]

Holland praises the fossil record as a record of past life:

> "As paleontologists, we have an extraordinary data set at our disposal, and we have the expertise to understand it. We have something that no other field of biology has—time, deep time—and we need to play to that strength. We have access to worlds far different from our own, with biotas, geographies, and climates unlike anyone has seen."[5]

I agree that paleontologists and scientists in general need to embrace the fossil record and accept the fossil record for what it is saying today. But doing so raises a conundrum for the evolutionist: the higher the fidelity of the record (of fossil species richness) is, the less evolutionists can appeal to the incompleteness of the fossil record to explain away the morphological gaps between fossil taxa. If the fossil record is so good, why have these gaps not been filled after 160 years more of collecting fossils, if evolution is true? The lack of intermediates, the gaps, are not only real and universal, but they are even more glaring after so many years of digging up fossils.[6] Michael Denton documents that 100,000 taxon-defining novelties are "not led up to gradually from some antecedent form, and which remain invariant after their actualization for vast periods of time."[7] The glaring, universal gaps in the fossil record should easily be enough to reject evolution, but paleontologists and many other scientists rarely draw this conclusion, likely because of a previous commitment to naturalism and evolution.

The fossil record is nearly complete due to Flood burial

Within creation science, the Flood buried the pre-Flood world. We would expect sudden appearance of fossils followed by stasis, unlike what is expected for evolution. Therefore, we would expect the fossil record to be complete, except for the small number of new fossils being discovered every year. These fossils do not change the nature of the fossil record: it contains universal gaps that can be explained by the creation orchard of life (figure 1). The fossil record is just what is expected from the creation of kinds in Genesis 1 with much variety within the kinds.

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Many flawed papers in sedimentology

Michael J. Oard

Veteran sedimentologist V. Paul Wright was asked to write a short editorial for a new section in the *Journal of Sedimentary Research*. He wrote it about a recent trend of flawed research in sedimentology. His conversations with other veteran sedimentologists confirmed his observations.[1]

In particular, he noted three problems. The first is accepting unsubstantiated claims as the basis for a new interpretation, which is, in turn, believed and repeated. He calls this a 'meme'. Second are studies based on non-existent data, which he calls 'fake news'. Third is the lack of empiricism. Sedimentologists feel free to reinterpret data sets without presenting any new research, or fail to question data.

Wright had noticed sloppy research much earlier, but it seems to have become a trend lately. This is likely due to the 'publish or perish' mentality combined with a great increase in researchers and journals over the years. He believes the problem is mainly poor editing and reviewing, which allows flawed papers to slip by. But he acknowledges that it is hard to find qualified editors and reviewers, especially those familiar with a particular outcrop. He provides one example of a flawed paper that had been rejected by a reviewer but was published anyway by the editor because the author was famous.

The pervasive reinforcement syndrome

The first problem with the meme or bandwagon effect is that false ideas can be widely believed for a long time. Wright shows how memes are produced:

> "Someone, often in an informal publication which was not peer reviewed, makes an interpretation without evidence, and that view is simply imitated repeatedly and never questioned until it is so widely accepted that data are simply fitted into that model without any objective analysis, and the unqualified interpretation ends up taken for granted and published in peer-reviewed journals."[2]

The problem may begin with editors, but peer review is also sloppy. Though it's not simply peer review, but also the development of dominant narratives that goes unquestioned. Worse, the investment in quasi-scientific narratives creates a backlash against anyone questioning them. This is equally true in creationism. Regardless of how this inaccurate research becomes mainstream, it reveals a lack of accountability and a lack of skepticism among researchers. It also stems from the explosion of journals and associated intense competition for hits, citations, etc.

This meme effect is close to the reinforcement syndrome.[3] The concept was first developed by Watkins,[4] who stated that the reinforcement syndrome is an inherent weakness in many fields of the experimental and so-called historical sciences. However, it is especially a problem in historical sciences because there is less ability to self-correct experimentally. Watkins gives the example of the clustering together of short geomagnetic polarity events of doubtful validity into specific periods of geological time. In other words, these paleomagnetic excursions were not well dated, but were simply given dates based on the nearest excursion determined by other researchers. Watkins considered the most famous example of the reinforcement syndrome is one that lasted 60 years—the concept of four Pleistocene ice ages (figure 1):

> "Perhaps the best known, or at least most significant, results of the 'reinforcement syndrome' in the geological sciences is the very firmly established concept of four glacial periods during the last Ice Age [i.e. four separate ice ages during the Pleistocene]. The initially defined system was confirmed by many different studies."[5]

Wright gives the example of microbial mats producing the sediments below the salt deposits off the coasts of the South Atlantic continents. Just because microbes are found does not mean the sediments were formed from mats.

Wright's second example of an unjustified meme is cyclostratigraphy, the idea that changes in Earth's orbital geometry causes cyclic ice ages or cyclical sedimentation. He mentions that the astronomical theory of the ice ages was developed in the 1800s with much supposed supporting evidence and unquestioned allegiance. It is instructive how the advocates seemed to be able to pick out the orbital signature among all the other factors (noise).[6,7] I am not sure Wright was thinking about the modern revival of this theory, which supposedly has claimed hard evidence since 1976. It was based on 'finding' Milankovitch cycles in deep-sea cores that just happened to match the three orbital cycles of about 100 ka, 41 ka, and 22 ka.[8] Such cores need variables that can be accurately measured down the core. Also, cores need to be accurately dated in order to show cycles. This dating is based on many assumptions, including deep time. I can't help but wonder just how much bias went into this dating.

Recently, Jake Hebert of ICR discovered that the secular scientists changed one of their 'tie points', believed to anchor the chronology from 'known dates' from other records. This was the tie point of the Brunhes paleomagnetic normal chron changing to the reversed Matuyama chron, which was dated at 700 ka when Hays *et al*.[8] did their research, but which was later changed to 780 ka. By plugging in this new tie point and rerunning

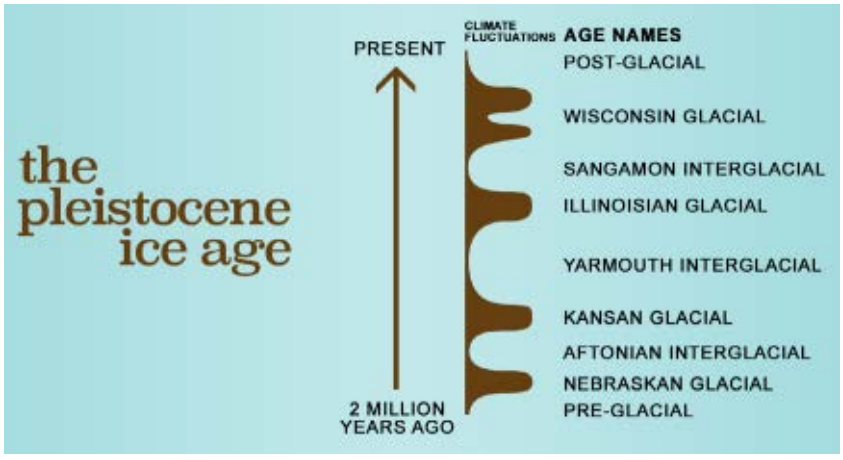

Figure 1. The four Pleistocene ice ages within the past 2 million years as displayed in the College of Eastern Utah Prehistoric Museum (text enhanced), now USU Eastern Prehistoric Museum, in Price, Utah, USA. Photo taken in the mid-1990s, about 25 years after secular scientists rejected the concept.

the spectral analysis, the Milankovitch cycles failed to show up.[9,10] Spectral analysis is used to find the predominant cycles in a time series. Thus, the linchpin for the modern revival of the astronomical theory has been shown to be false. Yet, thousands of papers have been published since 1976, assuming the truth of the astronomical theory, both in Pleistocene ice age studies[11] and in pre-Pleistocene sedimentology.[12]

Fake news

We have all heard of 'fake news'. Apparently, there is 'fake news' in sedimentology. Without giving references or the names of the outcrops, Wright gives two examples of reinterpretations he thinks were unjustified or fake results. One was repeating sedimentary rocks interpreted by four authors as storm-dominated, offshore deposits. The new interpretation described them as numerous shallow water cyclothems without critiquing the previous interpretation. The second problem was a reinterpretation of one of the most important outcrops in the world.

The problem with both of these reinterpretations lies in the fact that no new evidence was presented. Wright blames the reviewers, who probably were not familiar with the particular outcrop, and editors, who seemed to have just passed the papers on to publishing. I can't help but wonder how many differing interpretations of the same evidence there are in geology as a whole. It is probable that without the straightjacket assumption of uniformitarianism, many outcrops could be reinterpreted as the product of a massive flood.

Opinions with a lack of evidence

Wright brings up the issue of a lack of empiricism or evidence, in which opinions sway people, especially hasty opinions based on a small sample or lack of in-depth analysis. Wright describes one case that he describes as 'helicopter science':

> "I must add that I am not denigrating the use of helicopters, or drones, but am referring to studies where researchers 'drop' in to a section they barely know, ignore any local expertise, grab some samples which are taken without any consideration of context, depositional or diagenetic, perform some analyses, and propose, for example, a theory of changed global ocean chemistry, when if they had looked at the context of the sample they would have realized that their theory was deeply flawed."[13]

Such problems even more pervasive than Wright imagines

I believe Wright noticed only a small part of the bigger picture, problems that have been endemic since the Enlightenment. Countless examples of the reinforcement syndrome can be brought up in the so-called historical sciences. John Woodmorappe has documented many of them.[14] The most pronounced are those of an old earth and a slow progression of events and organisms, now fossils, through time, i.e. uniformitarianism and evolution. After the Enlightenment took over, all observed data from rocks and fossils have been *automatically* explained by that paradigm, whether or not they actually fit. The assumptions guiding the Enlightenment reinforcement syndrome are often claimed to be facts, but it is a form of circular reasoning. Because of the multi-generational effort, it is often difficult to unravel the pervasiveness of circular reasoning in bolstering the Enlightenment assumptions, but with enough study it does become evident.

Creation scientists must also be careful

Wright's insights into secular sedimentology should be taken to heart by creation scientists. We too must be careful to examine as much data as we can from the journals. Speaking of the earth sciences, it is also helpful to examine as much geology as possible in the field, which often is difficult since most of creation research is unfunded. It is also important for reviewers and editors to determine whether a certain paper has enough compelling supportive evidence and to keep objectivity; not allowing bias to determine whether to publish. We also must attempt to be neutral towards

new ideas that are being tested by those propounding the idea.

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Neandertals becoming more modern with time

Michael J. Oard

Many people and some scientists still consider Neandertals the last 'missing link' before man. Neandertals were first discovered in 1856 in the Neander Valley of Germany. They lived during the Ice Age, mostly in caves. Neandertal Man is often depicted as a brutish caveman. Numerous facial and skeletal reconstructions showed him half ape and half man. But since the first discovery, over 500 skeletons have been found. These reveal the true nature of Neandertal Man and the bias of evolutionists.

Fossil discoveries showing Neandertals a people group that left Babel

The depictions of Neandertal Man have completely changed in the past 50 years. Although once thought to have a brain about 10% larger than modern man, a better analysis shows that Neandertals had only a slightly larger brain than modern man,[1] which is three times the brain volume of an ape. This should have been powerful evidence that Neandertals were humans like us.

Neandertals buried their dead with flowers, a distinctly human trait.[2,3] Sometimes Neandertals were found buried with modern humans.[4] It is likely they built boats based on remains from Mediterranean Sea islands.[5,6] Neandertal Man likely crossed the Gibraltar Strait. All of these discoveries or deductions indicate early people, including Neandertals, and even *Homo erectus*,[7] built boats and could navigate the seas. And had much more intelligence than evolutionists have given them credit for.

At one time, paleoanthropologists believed Neandertals were physiologically incapable of complex speech.[8] A Neandertal hyoid bone was discovered in Israel in 1989 that was very similar to that of modern humans. The hyoid bone, from the region of the throat, is not connected to any other bones. It is very important for controlled speech. However, this did not satisfy many skeptics that Neandertals could speak like modern man. Based on newer technology, the internal structure and micro-biomechanical features of the hyoid bone were analyzed.[9] The results were consistent with Neandertals having complex speech, the same as modern humans. However, some skeptics were still not satisfied. They declared that just because Neandertals had all the features needed for complex speech, it does not prove that they talked like us. And besides, it was only one sample. From the new research, the old adage can be applied: "If it quacks like a duck, and looks like a duck, then it must be a duck."

Moreover, human hyoid bones have also been found with other Ice Age people groups.[9] For instance, *Homo heidelbergensis*, the supposed ancestor of Neandertals, had two human hyoid bones found at Sima de los Huesos in the Sierra de Atapuerca, Spain.[10] These cave fossils were at one time thought to be Neandertal, giving good indication that they were no different than Neandertals. However, they are now considered *Homo heidelbergensis*,[11] likely because they date the fossils to half a million years—too old for Neandertals.

Neandertal Man is also believed to have lived in the foothills of the western Ural Mountains just south of the Arctic Circle.[12,13] Apparently, they were smart enough to survive in what uniformitarian scientists assume was a very cold environment during the Ice Age.[14]

Neandertal Man had the controlled use of fire.[15,16] The evidence for this consists of 165 stones and stone artefacts, and several hundred animal-bone fragments found in a Spanish cave that display signs of heating up to 400–600°C, consistent with fire. Since the evidence was found about 8 m (26 ft) inside the cave, the researchers thought it unlikely that the signs of controlled fire were caused by sparks from a wildfire.

Scientists have also discovered the remains of an annular construction found 336 m (1,100 ft) within another cave in south-west France attributed to Neandertals.[17] They discovered a regular geometry of broken stalagmite circles with several traces of fire. This is the first evidence scientists found displaying Neandertal's construction ability and revealing a complex social network and evidence of communicating for a given end, to build a home within the cave.[18] Thus, "humans from this period had already mastered the underground environment which can be considered a major step in human modernity."[19] However, these scientists are speaking from the point of view of evolution. Neandertals did not need a major step toward humanity; they were already fully human. The authors also conclude:

> "Until now no evidence has been found for regular Neanderthal incursions into caves, except for a possible case of footprints, and Neanderthal constructions inside caves, at least at a distance that is no longer exposed to daylight, were totally unknown."[20]

The cave findings support other human abilities of Neandertals including painting sophisticated images on cave walls,[21] jewelry making,[22,23] and painting perforated marine shells for body jewelry.[24] Neandertals probably made bone flutes, and so could also make music.[25–27] It had been controversial whether Neandertal Man painted on cave walls, but new evidence indicates that they did indeed produce cave art. They did it before 'modern' people supposedly entered the area. The researchers even suggest that Neandertal Man may have taught the skill to modern man. Art is also a human characteristic.[28,29]

Neandertal Man was a sophisticated hunter and ate a diversity of food, including mushrooms.[30,31] They not only ate meat but also ate vegetables, fish, and birds, and hunted small, fast game such as rabbits. They even cooked their food.[32] The Neandertals used string, suggesting a high level of sophistication.[30] Hardy *et al*. also noted that much is missed in archeology because of biases in what the researchers believe and therefore look for. Moreover, the new results challenge the idea that innovation came late with the Neandertals and was passed on by modern man.

The recent discovery that a slight majority of Neandertals had mild to severe swimmer's ear, same as some modern humans, suggests that they dove for aquatic food.[33] Swimmer's ear is a bony growth in the ear caused by frequent diving, likely for fish or bottom animals. This find could point to a level of adaptability and flexibility in Neandertals. No fishbones had been found associated with Neandertals, but a new report by Zilhão *et al.* from caves along the coast of Portugal discovered that Neandertals ate a wide variety of marine organisms, such as marine invertebrates, fish, marine birds and mammals, tortoises, and waterfowl.[34] Generally, their diet was terrestrial. Most of the Neandertal fossils analyzed lived far inland, although they are associated with rivers and lakes. Swimmer's ear can also be caused by living in a damp, windy environment, which would have typified the Ice Age climate that followed the Genesis Flood.[33]

In summary, archaeology now confirms that Neandertal Man had numerous abilities that are attributed to modern man. The evidence is inescapable that Neandertal Man was just a people group, who left Babel, and settled in Europe and western Asia (figure 1). Ingrained ideas die hard, but the number of evolutionists who still consider Neandertal Man primitive are dwindling. Hopefully, it will soon be zero.

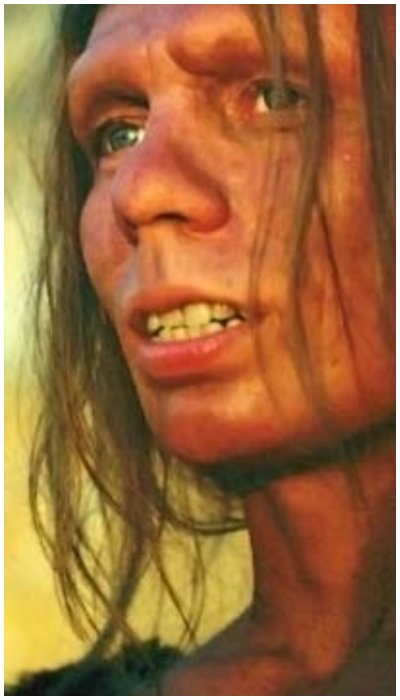

Image: Bacon Cph/CC BY 2.5

Figure 1. Reconstruction of a Neandertal woman

Neandertals intermarried and were absorbed into modern man

Secular scientists have two theories on why Neandertal Man disappeared. One is that he interbred with and was absorbed within modern man. The second is that Neandertals went extinct, possibly killed by other humans or even from climate change. Climate change seems unreasonable, since Neandertal Man survived during the Ice Age. The first possibility is now supported by genetics that shows Neandertal Man was absorbed into modern man through reproduction.[35] We know this from the DNA of Europeans and Asians today, which contains about 1 to 4% Neandertal

DNA.[36] Some people from that region still show Neandertal-like skull features. Even Africans have Neandertal DNA, as well as all other people of the world.[37] We all have Neandertal DNA.

Neandertal Man was a 'caveman',[38] but he was very intelligent. They were not half ape and half human as the culture tries to portray them. Cavemen are simply people who live in caves. Some people live in caves today, and have electricity and TVs! The insides of Neandertal caves were laid out like houses. They had covered dwellings within the cave, based on post holes found in the cave sediments. It is likely their 'houses' were covered with animal skins providing warmth and privacy.[39]

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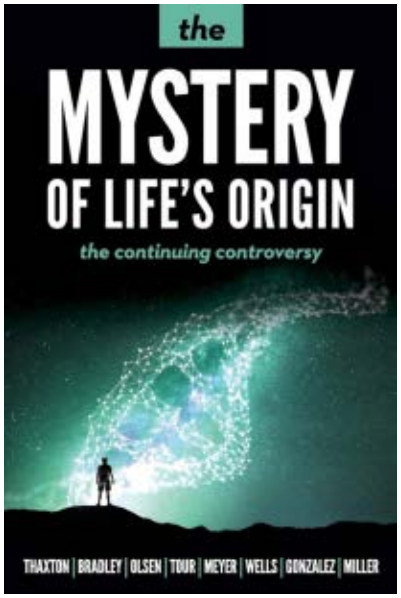
Update to classic chemical evolution critique

The Mystery of Life's Origin: The continuing controversy

Charles B. Thaxton, Walter L. Bradley, Roger L. Olsen, James Tour, Stephen Meyer, Jonathan Wells, Guillermo Gonzalez, Brian Miller, and David Klinghoffer

Discovery Institute, Seattle, WA, 2020



Jonathan Sarfati

Chemical evolution ('abiogenesis') is one of many intractable problems with evolution from goo to you via the zoo. How can non-living chemicals produce a living cell? In the 19th century, Joseph Jackson Lister (1786–1869)[1] improved light microscopes so much that biologists could see some of the complexity of a 'simple' cell. Charles Darwin (1809–1882) admitted, "our ignorance is as profound on the origin of life as on the origin of force or matter."[2] By the end of the 19th century, most cell organelles had been discovered.

Still, Darwin's followers were not deterred. They still had faith that undirected chemistry could generate life. In the 1920s, these ideas were cast in a basically modern form by Russian biochemist Alexander Oparin (1894–1980), who proposed that the earth's original atmosphere was reducing, i.e. rich in hydrogen compounds and lacking oxygen. Oparin proposed that simple building blocks of life could form from natural energy sources, and form living cells spontaneously. Independently, British biologist J.B.S. Haldane (1892–1964) proposed that organic molecules could form then accumulate in the oceans, forming what he called a 'hot dilute soup'.

These mostly theoretical ideas were supposedly validated by experiments in the 1950s by Stanley Miller (1930–2007). He was a graduate student of Harold Urey (1893–1981), winner of the 1934 Nobel Prize for Chemistry for discovering deuterium (heavy hydrogen). Together, they constructed a now-famous experiment using Oparin's gas recipe of methane, ammonia, and hydrogen, applying energy, and using a trap to collect products. After a while, the trap was found to contain small amounts of a few simple amino acids.[3]

After Miller died, his student Jeffrey Bada (b. 1942) re-analyzed some of Miller's old samples, including results of experiments that included hydrogen sulfide. Miller had not published on these, but Bada found a few more amino acids.[4]

The same year (1953) that Miller first published his experiment, the structure of DNA was unravelled. This added a new layer of complexity to the cell, already known to be far from simple. That is, DNA was clearly a carrier of digital information that coded for the complexity, which could be transmitted from generation to generation.

Early modern creationist critiques

However, these ideas were hardly unopposed. Informed critics of evolution pointed out huge flaws on both chemical and informational grounds. In the early days of the modern creationist movement, European triple-doctorate chemist/pharmacologist A.E. Wilder-Smith (1915–1995) wrote the influential book, *The Creation of Life: A cybernetic approach to evolution* (1970).

Leading chemical evolutionist Dean Kenyon (b. 1939) was given this book by a student around 1976. Kenyon admitted, "I found myself hard-pressed to come up with a counter-rebuttal."[5] He later became a creationist after studying other creationist works. Dr Wilder-Smith first raised the severe problem (for evolutionists) of the origin of new information. Bill Dembski (b. 1960), one of the leaders of the Intelligent Design Movement, credited Wilder-Smith as "particularly important … . Making rigorous his intuitive ideas about information has been the impetus for much of my research."[6] Wilder-Smith also pointed out the problem of homochirality,[7] a topic of one of his doctorates.

In the USA, Duane Gish gave up a promising career in protein synthesis to work at ICR. Leading chemical evolutionist Sydney Fox admitted that Gish was "co-author of a number of outstanding publications in peptide chemistry."[8] Not surprisingly, Gish over the years wrote devastating critiques of chemical evolution, and frequently debated leaders in that field on university campuses.[9]

The Mystery of Life's Origin

Meanwhile, outside the biblical ('young earth') creationist circles, physical chemist Charles Thaxton

(b. 1939), materials scientist Walter Bradley (p. 1943), and geochemist Roger Olsen wrote a ground-breaking book. *The Mystery of Life's Origin* was first published by Philosophical Library in 1984. Dean Kenyon wrote the foreword.

This book became the 'go-to' book for origin of life critiques, deeply penetrating the chemical weaknesses of chemical evolution, and putting the informational weaknesses on a firm foundation. Although the book is 36 years old at the time of writing, most of the arguments are still cogent. We published a review of the original edition in the last millennium.[10]

Chemical problems

While Haldane's 'primordial soup' has become part of common scientific 'knowledge', there is not the slightest evidence that one ever existed on Earth. Rather, any biological 'building blocks' would have been destroyed by UV, diluted, hydrolyzed, and cross-reacted destructively with each other. E.g. sugars and amino acids could not co-exist in a primordial soup because of reactions between the amino groups ($–NH_2$) of the amino acid and carbonyl groups (>C=O) in the sugars that would destroy both. These are *Maillard reactions,* known to food chemists as a source of flavouring and browning of heated foods. However, they are a serious problem for chemical evolution.

Even the right type of reaction can be in the wrong place, e.g. there are three possible binding spots on adenine and five on ribose, and three possibilities to attach the phosphate group. Of the 90 possibilities, only one is used in life. Vast eons of time are not the friend of chemical evolution, but the enemy. That's because there is more time to reach equilibrium, which is far away from life (chap. 4).

The Oparin–Haldane model required a reducing atmosphere, and this is what the Miller–Urey experiments used (figure 1). However, the geochemical evidence offers no support that such an atmosphere ever existed on Earth. So, the reducing atmosphere has largely been abandoned. There is even quite strong evidence that the earliest atmosphere contained oxygen. This would have been fatal for any primordial soup idea because it would prevent biomolecules from forming. Or if oxygen appeared later, it would destroy any biomolecules that had formed (chap. 5).

Are these simulations truly legitimate evidence for chemical evolution, with no intelligence allowed? They all required intelligent investigators to set them up and run. Some of the investigator input is not objectionable though. For instance, to test the Oparin claim about what would form in a mixture of reducing gases, it is fair to set up an experiment with those gases.

The products would probably end up in the oceans, so maybe it's OK to have a water trap for them. But then, not if the trap is unlike what could occur on the earth. The Miller experiments quickly blew the products away from the energy sources then trapped them safely. But on the primordial earth, the compounds would remain exposed to the energy sources that produced them. But the energy is far better at destroying than making them. Even in the ocean, these molecules would not be safe, because UV penetrates water (you can get sunburned while swimming). So traps are probably above the threshold for legitimacy of investigator interference.

Clearly above the threshold is the usual scenario: find a trace of compound X in a spark discharge experiment, claim 'see, X can be produced under realistic primitive-earth conditions'. Then they obtain pure, homochiral, concentrated X from an industrial synthetic chemicals company, react it to form traces of the more complex compound Y. Then this is touted as proof that Y could have formed in a

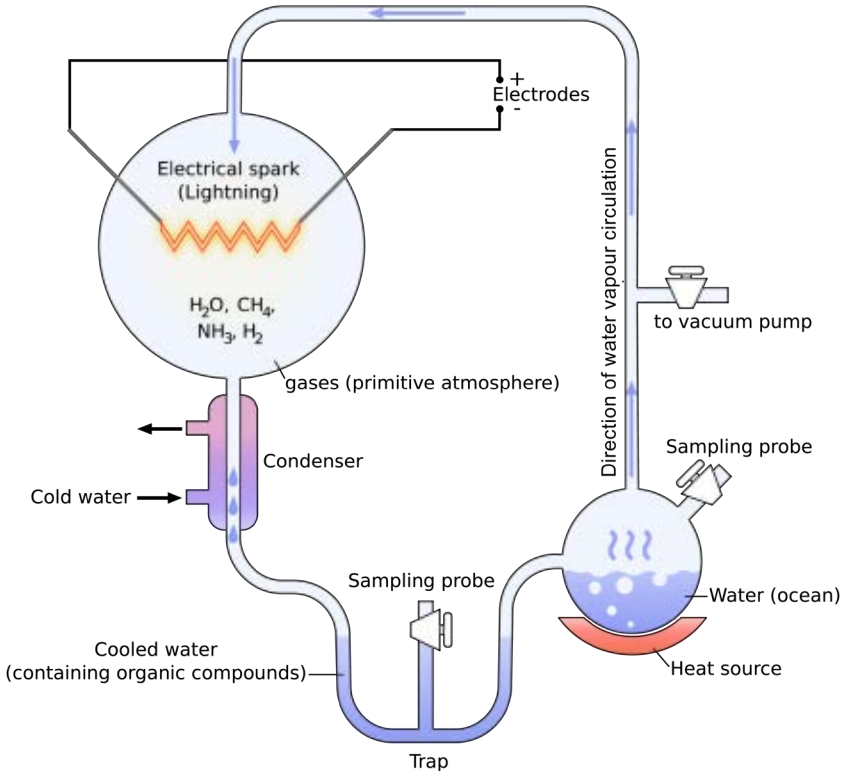


Image: GYassineMrabet/CC BY-SA 3.0

Figure 1. The famous Miller–Urey experiment. The original used reducing gases that are no longer thought to have been in the earth's atmosphere. The experiment also moves newly formed products out of danger from being destroyed by the spark that formed them.

primordial soup. But in reality it would never have arisen without much intelligent investigator interference. Typically, the process is repeated to form traces of Z from purified Y, and so on.

Informational problems

This book was probably the first to present rigorous thermodynamic and informational arguments (chaps 7–9).[11] Both of these topics have been misunderstood by both evolutionists and creationists.

First, the issue is explaining what is unique about living creatures. The leading evolutionary origin-of-life researcher, Leslie Orgel, who had previously made very important contributions to transition metal complexes, outlined this:

> "Living things are distinguished by their specified complexity. Crystals such as granite fail to qualify as living because they lack complexity; mixtures of random polymers fail to qualify because they lack specificity."[12]

If we compare this to printed material, a random polymer is like a book of random letters, a crystal is like ABCD repeated, and a protein or DNA strand from a living creature is like a play of Shakespeare.

To elaborate, a *crystal* is a repetitive arrangement of atoms, so is *ordered*. Such ordered structures are usually in the configuration that has the lowest energy—so they will form spontaneously at low enough temperatures. And the information for making the crystals is already present in their building blocks (for example, directional forces between atoms). For example, a salt crystal has a very ordered cubic structure, but this is just the same arrangement repeated many times (figure 2). If you crush a large salt crystal into microscopic dust, the dust grains are just tiny crystals with the same arrangement, just repeated fewer times. There is no real difference between the large and small crystals apart from size.

But proteins and DNA, the most important large molecules of life, are not ordered (in the sense of repetitive) but have high *specified complexity*. If a DNA strand were broken, it would lose its information. A large DNA strand is different from lots of smaller ones. The same applies if a protein were broken.

There is nothing in the chemistry of the building blocks of proteins and DNA that would make them join up in predetermined ways, any more than the forces between ink molecules make them join up into letters and words. Michael Polanyi (1891–1976), a former chairman of physical chemistry at the University of Manchester (UK), confirmed this:

> "As the arrangement of a printed page is extraneous to the chemistry of the printed page, so is the base sequence in a DNA molecule extraneous to the chemical forces at work in the DNA molecule. It is this physical indeterminacy of the sequence that produces the improbability of any particular sequence and thereby enables it to have a meaning—a meaning that has a mathematically determinate information content."[13]

The mathematical determination comes from standard statistical thermodynamics:

$$S = k \ln\Omega$$

where S is the entropy of the system, k is Boltzmann's constant, and Ω corresponds to the number of ways the energy and mass in a system may be arranged.

The entropy can be subdivided into thermal entropy, S_{th}, the arrangement of energies, and configurational entropy, S_c, the arrangement of matter. In particular, for living systems, the relevant arrangements are amino acids in protein and nucleotides in DNA.

For random polypeptides and nucleic acid strands, there are astronomically many possible arrangements (Ω_{cr})—more than the number of atoms in the known universe. But there are very few arrangements that constitute meaningful DNA sequences, e.g. that code for functional proteins (Ω_{cm}). Going from random to meaningful polymer is thus a *reduction in configurational entropy.* This can be equated with an increase in *information*:

$$I = S_{cr} - S_{cm} = k \ln\Omega_{cr} - k \ln\Omega_{cm}$$

Tying this to standard classical thermodynamics, for a reaction to be spontaneous, the change in Gibbs free energy must be negative. This is provided by:

$$\Delta G = \Delta H - T\Delta S_{th} - T\Delta S_c$$

(Gibbs free energy) = (Chemical work) – (Thermal entropy work) – (Configurational entropy work)

Forming any sort of polymers is a huge problem, because of the chemical and thermal entropy work that must be done.[14] Attempts to form polymers using certain chemicals and energy flow under plausible prebiotic conditions have ended in failure. To form an informational polymer is much harder still because configurational entropy work is about 35% of the total for proteins, and 8.5% for DNA. And this doesn't include the work of selecting the right chemicals from the gunk produced by Miller-type experiments, in their right isomers, and combining them in the right way (figure 1).

A major problem for chemical evolution is that neither activated chemicals nor energy flow will do the necessary *configurational entropy* work. Compare this to building skyscrapers: a crane can provide the energy needed to lift heavy building blocks to a given height. But no matter how powerful the crane, by itself it will not place them in the right arrangements.

Philosophical

The authors argued that an intelligent designer was a legitimate explanation. This was before there was an official 'Intelligent Design' movement. One important point was the distinction between operational and origins/historical science. This has

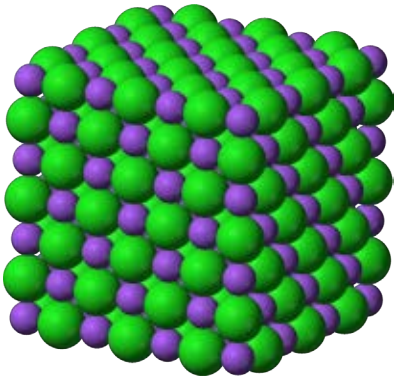


Figure 2. A sodium chloride crystal is just a repetition of the same thing, many times. A DNA strand in a living cell is very complex and non-repetitive.

been an important point that CMI writers and speakers make frequently.

Updated edition

The new edition first essentially reprints the original. The only updates are in the references, with online links to articles provided, because the internet was still in the future when the book was first released. The main updates comprise additional chapters by experts in different fields.

James Tour

Dr James Tour (b. 1959) of Rice University is one of the world's leading synthetic chemists—he made "the first reversible electronic switch out of molecules".[15] He is also vocally critical of chemical evolution papers. Tour points out that they gloss over too many of the needed steps of a real chemical synthesis, which require expensive and sophisticated laboratories.

He points out major hurdles, such as: selecting the compounds to go forward, purification, the right order of chemical reactions, controlling temperature and pH, and mass transfer (how do we get enough of the starting material to produce usable quantities of end product?). For living creatures, homochirality is a big problem that Tour raises, but which was only touched upon in the original book.

Stopping the reaction in the right place is important for chemical evolution. Evolutionists propose that sugars formed by the formose (or Butlerov) reaction that involves formaldehyde and alkali. But the very same alkaline conditions destroy aldose sugars (such as ribose and glucose) via the Cannizzaro reaction (this converts two molecules of aldehyde to an alcohol and an acid). Therefore, isolating the sugars requires an intelligent chemist to stop the reaction at the right time.

Indeed, Tour points out that the processes he supervises produce molecules far simpler than a living cell. So *a fortiori,* if undirected chemistry couldn't produce Tour's compounds, how could they produce life? In general, Tour's chapter is a worthy addition to the book.

Brian Miller

Dr Miller is a physicist. His chapter updates and reinforces the powerful arguments from thermodynamics and information. The fluctuation theorems formulated after the first edition provide no support for chemical evolution. RNA is too unstable for information storage—it is about 100 times less stable than DNA, and DNA is itself unstable over long periods of time. The 2015 Nobel Prize for Chemistry was awarded for this discovery and its implications:

> "In the early 1970s, scientists believed that DNA was an extremely stable molecule, but Tomas Lindahl demonstrated that DNA decays at a rate that ought to have made the development of life on Earth impossible. This insight led him to discover a molecular machinery, base excision repair, which constantly counteracts the collapse of our DNA."[16]

Miller also reinforces the homochirality problem, pointing out that homochiral solutions racemize over time.

Guillermo Gonzalez

Dr Gonzalez is famous for his work showing that the earth is a 'privileged planet'.[17] Here he applies this to the origin of life. There is limited usefulness, because he assumes the long ages and the general evolution of the solar system. But he shows that even given these assumptions, there is an extremely narrow window between the 'late heavy bombardment' and evidence of first life. Far from 'billions and billions' of years, there was at most 200 million years. Even most evolutionists would regard this as too short for chemical evolution.

Gonzalez also addresses the mutually incompatible scenarios required for production of different building blocks. For example, one scenario for producing building blocks of life is alkaline waters from hydrothermal vents. But hot alkaline solutions would destroy sugars and hydrolyze the amino acids serine, threonine, cystine, cysteine, and arginine. Also, hydrothermal vents are incompatible with other chemical evolutionary scenarios that require ultraviolet radiation to produce solvated electrons.

Jonathan Wells

For years, Dr Wells has been refuting 'icons of evolution' that appear in textbooks to indoctrinate students into evolution.[18] The Miller-type experiments are one infamous icon. Wells shows that the original experiment produced nothing that would itself go further. Attempts to salvage the experiment, with a neutral rather than reducing atmosphere, work even less well.

Wells reminds us of the problem of intelligent investigator interference, and he refers to the German organic chemist Clemens Richert:

> "We do our best to perform experiments that we believe re-enact possible steps of prebiotic evolution, but we know that we need to intervene manually to obtain meaningful results. Simply mixing chemicals and watching for a living system to appear from the broth seems unreasonable to me. This approach has never worked, and it is not expected

to work, at least not if one is limited to the lifetime of a human, let alone the duration of a funding period or a Ph.D. thesis. …

So, the periodic addition of a chemical condensing agent may be unavoidable to drive biochemical reactions that are endergonic, even in 'minimal intervention' experiments. Without the chemical activation, equilibrium (death) sets in. So, some level of human intervention may always be required for complex, multistep processes. After all, what the dominant activation agent was before enzymes began to use ATP will remain an enigma to many of us for the foreseeable future."[19]

Stephen Meyer

Dr Meyer is a leading light in the Intelligent Design movement. His chapter elaborates and updates the design and information arguments. Meyer cites the rigorous work by Douglas Axe that refines the informational argument. That is, are there many possible ways to make a functional protein? If there were, that would reduce the information content and thus the necessary reduction of configurational entropy.

For a protein to have enzyme activity, the bare minimum is functional folds. Dr Axe took a working enzyme beta-lactamase, which bacteria possess to destroy beta-lactam antibiotics such as penicillin. He took a functionally significant 150–amino-acid part of this enzyme, replaced side chains with random sequences, and tested them for stable folding. From this, he estimated the number of functional sequences compared with the number of possible sequences of 150 amino acids. He concluded:

"… the overall prevalence of sequences performing a specific function by any domain-sized fold may be as low as 1 in 10^{77}, adding to the body of evidence that functional folds require highly extraordinary sequences."[20]

Meyer critiques the popular RNA hypothesis, which was not so popular when the book was first published. He shows that even the building blocks are implausible, requiring extensive intelligent investigator interference. And the 'building blocks' don't *build* anything—they don't normally polymerize to any sequence, let alone functional ones. The self-copying ability is extremely limited to only about a tenth of its length.

Some claims of RNA copying itself have nothing to do with joining single building blocks on a template, as living things do. Rather, a single RNA strand catalyzed the formation of a single bond between two matching halves with predesigned complementary RNA sequences.

There is much talk of 'ribozymes', i.e. 'RNA enzymes' with catalytic activity. But while ribozymes can catalyze a limited number of energetically favourable reactions, they can't couple energetically favourable and unfavourable reactions as protein enzymes can.

Meyer rounds out the book by showing that the design hypothesis is good science, so we don't need the dogma of methodological naturalism to explain origins. It is *not* an argument from ignorance, or 'god of the gaps'. Rather, it is an *argument to the best explanation* based on what we *do* know about chemistry and information theory.

Conclusion

The book *The Mystery of Life's Origin* was a classic for its time, recommended for anyone with an interest in refuting chemical evolution. This updated edition with several new chapters is worthwhile for the current generation.

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Just a brain? I think not!

Am I Just My Brain?
Sharon Dirckx
The Good Book Company, UK, 2019

Lucien Tuinstra

Dr Sharon Dirckx[1] received her doctorate in brain imaging from Cambridge University and has held research positions at the University of Oxford and the Medical College of Wisconsin. She is Senior Tutor at the Oxford Centre for Christian Apologetics and an apologist with Ravi Zacharias International Ministries. With *Am I Just My Brain?* Sharon Dirckx's strong Christian faith is in plain view as she colourfully discusses our grey matter in eight chapters, each covering a different question.

Inevitably, one such topic is the existence of the soul and the nature of mind and thought. She also considers the plasticity of the brain, the extent to which it may be reorganised. Transgenderism is briefly covered; the materialistic worldview is actually at odds with claims made by the transgender movement that the physical gender may be wrong, and that one's identity is a matter of choice. Clearly both cannot be correct (p. 38) and biblically speaking it is safe to say that *both* views are wrong. Are we just machines or more than that? What about our subjective conscious experiences (qualia)? Is free will illusory and our (religious) beliefs as human beings merely hard-wired, a function of brain activity?

Using various analogies and anecdotes, Dirckx demonstrates that the materialistic worldview, including the human brain, does not account for the experiences people have. Scientific naturalism cannot explain everything.[2] Rather, *Am I Just My Brain?* is a philosophical question (p. 21).

Neural hardware versus software

How the brain really operates is not fully understood. Yes, we know the 'hardware' contains many synapses and neurons (figure 1), but none of these parts actually think. It is baffling how some neuroscientists on one hand can admit that the brain's function is still a mystery, but on the other that it is the whole person. Describing computer hardware (a third person observation) says nothing about any 'software' running on it. Similarly:

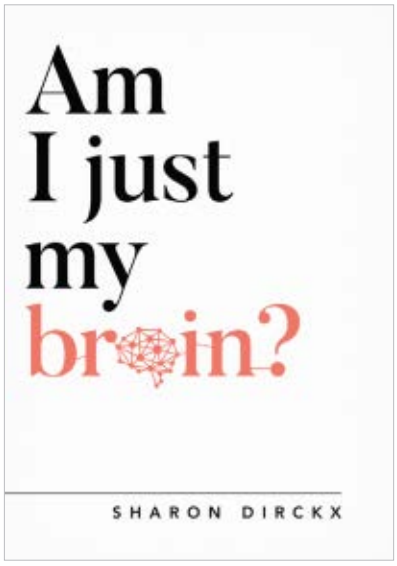
> "No amount of knowledge of rods, cones, corneas, light transmission, electrical stimulation of the optic nerve and image generation in the brain would get [blind] Mary any closer to the experience of what it is like to actually *see* [emphasis in original]" (p. 47).

The brain's 'software' is very personal—a first person perspective–including qualia and consciousness (p. 45).[3] Hardware does not generate software. Just as well, because you are not me, even though our neurons and synapses are made of the same stuff. Therefore, the statement "you are just your brain" is clearly self-refuting if matter is all that is, because that statement itself is not part of matter; rather, it is information. This answers the first of three questions Dirckx lists to test a worldview (pp. 26–27):

1. Is it internally coherent?
2. Does it have explanatory power?
3. Can it be lived?

Does the immaterial play any role?

Atheist Sam Harris, whose Ph.D. is in neuroscience, 'believes' that "Free will is an illusion." Yet, in the same breath, he says:



> "if I were to trade places with one of these men, atom for atom, I would be him… . There is simply no intellectual position from which to deny this. The role of luck, therefore, appears decisive" (p.76).[4]

It is very ironic that such a hardline determinist should say that luck is decisive; naturally, Harris could not help himself. Interestingly, this irony was missed by a man who received a degree in philosophy from Stanford University and, remarkably, practised meditation for more than 30 years.[5]

Clearly there is more to these things than Harris believes: immaterial things frequently affect the material, and vice versa. Dirckx gives numerous examples:

> "Cyber-bullying can cause a child to lose their appetite… . Being asked on a date … may cause blushing… . Crying … could be triggered by the news that a loved one has died" (pp. 70–71).

In the case of Phineas Gage (p. 59), a work accident caused a metal rod to shoot through his skull, destroying most of his left frontal lobe. He survived, but his personality changed (that is, according to many psychology textbooks and articles): formerly mild-mannered, his newly acquired profane and inappropriate behaviour resulted in him losing his job. To adherents of the idea that the person (be it his mind,

soul, or character) is in fact the brain, the explanation is simple: Gage's brain was severely damaged, and thus his personage too. But what if he had lost his eyesight, or a limb? Is it possible that his personage likewise might have changed, being unable to see or walk for instance? Surely most people would be heavily affected by such a trauma? What's more, after Gage recovered, the evidence indicates he lived a respectable life. Perhaps the scars of this horrific accident made for awkward stares which made him respond harshly, but such alleged anecdotes are not apparent from his family life or working with animals.[6]

What about the world of medicine? When trialling a new medicine, a control group is given a placebo, to compare the results of those who received the medicine and those who didn't. There are reports of people in the control group recovering, even though they were not administered the active drug. Is this a case of mind over matter? Can it be that people were healed because they truly believed they were treated with an effective medicine, even though they were not? This placebo effect is at odds with a purely materialistic view of the world (p. 50). The same applies to the nocebo effect, the influence of negative expectations on a patient's outcome.[7]

"Human beings straddle the material and immaterial realms", states Prof. Michael Egnor, a paediatric neurosurgeon of Stony Brook University School of Medicine, New York (p. 69).[8] This is not surprising to people familiar with Scripture. When the Bible speaks about the complete person, it speaks of spirit and soul and body (1 Thessalonians 5:23); only one of these represents the material. The Word of God can divide both the immaterial soul and spirit, as well as the material joints and marrow (Hebrews 4:12).[9]

Is it liveable?

There are people who have taken the material perspective to the extreme. Instead of talking about the experience of 'butterflies' (or similar) when describing being in love, they talk about endorphins. While this would be technically correct in such a context, it would certainly not bode well in a romantic setting! Unless of course the recipient responds by releasing more endorphins when talking about endorphins.

Dirckx spends quite a bit of time discussing God and his relationship with mankind. God's unconditional love for us is not associated with any hormones or other biological molecules—it's not a fleeting feeling. The ultimate example is, of course, the Creator, who showed "his love for us in that while we were still sinners, Christ died for us" (Romans 5:8). Being made in His image, people can extend grace to others too, sometimes referred to as random acts of kindness (RAOK). Dirckx addresses whether free will is an illusion. If it is, the chemicals in our brain must be what determine RAOK, in which case the misnomer RAOK should simply be called 'acts': there is nothing random or kind about laws of nature—they just are.

Similarly, our religious beliefs would then be hard-wired as well. The brain's circuitry, rather than our volition, would 'decide' what we do with Jesus' atonement at the Cross. It would mean that those who believe in the risen Christ cannot do anything *but* believe that—they cannot help themselves. Yet, we would also have to acknowledge that those who follow, say, Mohammed or Buddha—or Darwin—are equally wired to do so (p. 95).[10]

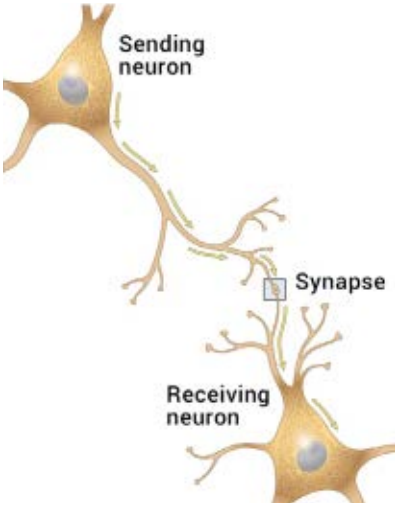


Figure 1. Neurons connect via synapses.

All in all, the purely materialistic view of the brain would make the genetic fallacy (judging something by tracing it to its source) redundant. Whether something is good or bad becomes meaningless, because such a qualification has no intrinsic, material basis; it is merely an artefact of synaptic firings. Morality doesn't really exist in an atheistic worldview.

Closing comments

This slim volume covers a topic that many people may find interesting, whilst at the same time making a case for the existence of God:

> "Brain activity, far from being a threat to God, is exactly what we would predict. … If there were no brain activity during prayer, this would give more cause for concern!" (p. 113).

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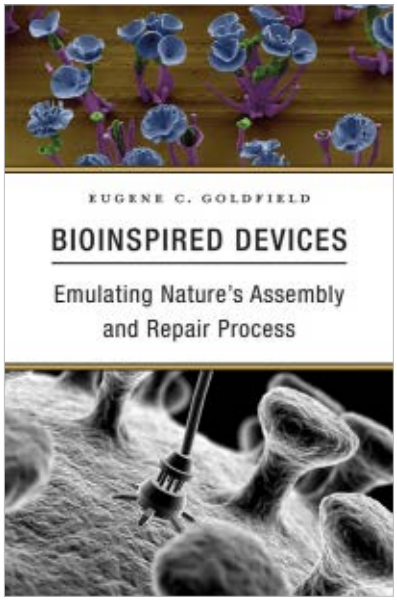
10. Of course the word 'equally' is misplaced, because clearly these are very different faiths, not least on the topic of grace.

Biological plagiarism: emulating nature without due credit

Bioinspired Devices: Emulating nature's assembly and repair process

Eugene C. Goldfield

Harvard University Press, 2018



Philip B. Bell

The title of this handsomely produced book suggests an overview of the many engineering advances made possible by the burgeoning field of bioinspiration, aka biomimetics. The author's credentials are not in doubt. Eugene Goldfield is Associate Professor of Psychology in Psychiatry at Boston Children's Hospital, Harvard Medical School. He is also on the faculty of the Wyss Institute for Biologically Inspired Engineering at Harvard University, and this book inevitably highlights work being done there, as well as by a plethora of other researchers globally; for example, Goldfield has done much work on wearable robots for young children (p. 33). Unsurprisingly, *Bioinspired Devices* receives praise from his peers—it certainly promises much. Throughout the book, copious use is made of tables and figures (some in full colour), copied or compiled from the academic literature.

Unfortunately, it is a rather tedious tome, distended by the author's laborious, jargon-heavy reportage of facts from a vast array of well over 1,300 academic papers (pp. 377–443). Often there is little discussion or application. Goldfield has the knack of concentrating on the minutiae of such studies in an obtuse, almost inaccessible manner! Moreover, he seems to assume that his readers will need little assistance in grasping the technical vocabulary of multiple fields of medicine, molecular biology, neuroscience, computer science, engineering, and much more. I doubt there is a polymath alive who could honestly access all of this material without resorting to a large amount of cross-referencing and additional reading. This is a shame.

Additionally, while chapters five and six (pp. 149–233) plumb the depths of cutting-edge neuroscience research (passed over in this review due to space constraints), it is disappointing that the material is not connected there and then to the book's theme: bioinspiration. Chapter seven, "How nature remodels and repairs neural circuits", does advance the discussion, but it is similarly tough going: one sentence (pp. 197–198) runs for 87 words, not including a further 34 words, abbreviations, and dates in parentheses! Not until the last chapter (from p. 338) is there a really focussed treatment of bioinspired devices themselves, although the author does use chapter four (pp. 111–146) to outline *how* bioinspiration engineers are emulating biology in building their own devices. These negatives aside, this is an intriguing book with respect to the origins debate.

Homage to evolution

Of 10 chapter titles, half of them personify nature as an intelligent, forward-thinking, creative agency. In fact, such 'secular-god-substitute' language so peppers Goldfield's terse, academic writing that I quickly decided to record the instances. The following statements (or close equivalents) evidence sheer evolutionary faith: "nature builds" (27 times), "nature uses" (5 times), "nature remodels" (4), "nature harnesses" (3 times), "nature leverages" (twice), "nature achieves", "nature invents", "nature has conserved", and "nature has discovered". We also read of "nature's solutions" (8 times) or "evolutionary solutions" (p. 235), and that things are "corrected by nature" (p. 30), plus other personifications that I pass over here. Never is the slightest justification given for these non–evidence-based assertions, which does not befit a serious academic text.

In these and other ways the author is careful to affirm his belief in the creative, innovative power of evolution. For instance, excitatory inputs of mouse motor neurones arose through "the evolutionary organization of the rhythm generating circuit, necessary for the emergence of bilateral appendages" (p. 172). And certain regions of the cerebral cortex represent, he says, "a significant evolutionary advance" (p. 182). Discussion of how this occurred is restricted to bland suggestions: what "may have been", "may have", "may not be" (p. 207).

Hallmarks of nature worth emulating

Goldfield argues that we can think of the sensory organs of humans and

Image: Kostas Karakasiliotis, Biorobotics Laboratory, EPFL

Figure 1. *Salamanda robotica*, a waterproof salamander robot designed both to swim and to walk on land. It has eight motors to perform spine undulations and extra motors to power each leg (discussed in Goldfield, pp. 242–246).

various other organisms as smart instruments. Indeed, but, holding to "our evolutionary heritage in animals" (p. 46), he also says these "have evolved through tinkering" (p. 8). Bioinspired research with that premise obviously contrasts with an *a priori* acceptance of originally perfect biological designs which were corrupted subsequently (Genesis 1:31; 3:17–19). People like Goldfield are not consciously "thinking God's thoughts after Him" but are 'thinking Darwin's thoughts after him'.[1] Nevertheless, theirs is a laudable aim, to try to integrate the human body with complex artificial systems in order to repair congenital defects, ameliorate the impact of sensorimotor damage (e.g. due to strokes), to create improved prosthetics for those paralysed by life-changing injuries, and much more.

The various hallmarks of (divine) design may not be recognized as such, so that naturalistic biomimeticists like Goldfield may justifiably be accused of what I call biological plagiarism. Nevertheless, he obviously recognizes the rich pickings to be had from detailed study of the natural world. Much can be learnt from considering the fundamental characteristics of living organisms (pp. 15–31). For a start, the complex systems of various organisms are wonderfully *robust*. Also, the ways in which an animal's anatomy and nervous system integrates with the environment (including "reciprocal and dynamical … coupling") are remarkable. Looking to the future, bioengineers anticipate the seamless integration between man-made devices and the body's organs and systems. For example, such aids would then be fully *embodied*, much as a discarded shell becomes an extension of a hermit crab's body. This would be true whether these devices were placed inside the body (e.g. a computer-aided muscular actuator) or worn like a piece of clothing.

More complex organisms are *anticipatory*, especially those with significant brain function, something that advanced robotics research seeks to emulate. In future, devices will be increasingly *smart*, better inspired by the ingenuity of animals in their apparently mundane tasks, such as searching for life-sustaining food and water. Scientists are working hard to copy the *self-repairing* ability of biomaterials like bone. And, at a deeper level, by studying the novel properties arising in self-organizing, complex biological systems (so called *emergence*), scientists are seeking to better treat people with various psychopathologies and brain diseases. These features and more are worth emulating.

A wellspring of ideas

Goldfield's vision for bioengineering is founded upon *how* and *what* "nature builds, controls, and manufactures" (p. 31), the subject matter of chapters two and three respectively. Along the way (and this is a feature of this book as a whole), he showcases many of the advanced scientific techniques being employed to advance our understanding of diverse biological fields, such as: morphogenesis,[2] tensegrity (tensional integrity),[3] embryogenesis, cellular networks, epigenetics,[4] breathing, and swallowing. The point is these are all rich sources of bioinspiration, albeit that the details of this research are not developed until much later in the book.

Biomaterials galore are a treasure trove in this field: structural ones like plant cellulose, chitin, and collagen (in various animals); rigid ones (like wood, coral, and tooth enamel); tensile ones like spider silk; pliable ones like resilin (the tendons in insect wings); and composite ones like animal cartilage, bone, and the gel of jellyfish. Of course, many biomaterials possess more than one of these properties.[5] And the ways in which these biomaterials are constructed into such items as turtle shells, crustacean appendages, or squid eyes are enormously enlightening for scientists. Sadly, whatever the marvel under consideration, the god of naturalism gets the credit; for example,

> "… nature's materials achieve the seemingly contradictory requirements of being sufficiently stiff to support a load yet tough enough to resist crack propagation, by the self-assembly of *composite* materials into hierarchical structures with interfaces" (pp. 74–75).

At a higher level, the biological smart instruments mentioned earlier are ripe for scrutiny: the stride generator of a crab, the odometers of ants and bees, the sun-compass of migrating birds and butterflies, and the altitude controllers of humble flies (p. 89) are all fascinating and inspiring. Well might biomimetics experts both envy and try to emulate the exquisite mechanosensory perception of even the lowliest creatures. An

outstanding example is the bizarre-but-brilliant nasal organ of the star-nosed mole, with its twenty-two nasal rays and "25,000 epidermal touch domes (papillae) called Eimer's organs, innervated by more than 100,000 myelinated fibers" (p. 92). Such is the precision of this organ that it operates more like the retina of visual systems, a sort of 'tactile eye'—smart indeed![6]

Even tiny *Drosophila* (the well-known genus of fruit flies) can navigate and fly to habitable oases across many kilometres of open desert. How? By making use of a "repertoire of instruments common in many insect species", such as "a sky compass to read the polarization of the sky", not to mention an "optical flow detector, and odor plume tracker"—and all of the fruit fly's super-miniaturized smart instruments are integrated together (p. 94).

From the smallest to the largest scales, bioinspiration scientists are also learning a great deal about mechano-transduction, for example, studying hearing mechanisms, hydrostatic skeletons (such as in *Octopus vulgaris*), and 'nature's pumps'. We might not be surprised to learn that the tongues of marvellous nectar-sipping hummingbirds are actually elastic micropumps. But how many people who watch a dog thirstily lapping up water appreciate that they are witnessing a complex hydrostatic pump in action (p. 101)? At every level, the sheer wealth of species available for study constitutes an inexhaustible wellspring of research leads.

Exciting developments

Until now, I have referred to bioinspiration scientists, bioengineers, and biomimeticists. In fact, these umbrella terms represent the collaborative efforts of biologists, medical scientists, clinicians, engineers, robotics experts, computer scientists, and more. Goldfield relates many examples of intriguing achievements that have come about through such fruitful partnerships.

Figure 2. Wearable prosthetic limbs are of enormous benefit to individuals. Integrating these with a person's nervous system, enabling conscious movement, is no longer science fiction, but there is still a long way to go.

There are many bioinspired adaptive materials: self-healing ones, slippery liquid-infused porous surfaces (SLIPS), and helically assembling bristles with adhesive and particle-trapping properties (pp. 115–121). Some groups are constructing organ-on-chip microfluidic devices that can model tissue or organ physiology (pp. 121–122). Muscle–tendon units, "a marvel of nature's engineering", are being emulated in order to better mimic their motor function and their spring-like, braking, stabilizing and energy-storing capabilities (pp. 123–126). Further fields of investigation are soft sensors, actuators, 'programmable matter', soft robots, water-jumping robots, robobees and octobots (pp. 127–146).

Medically, there is exciting cutting-edge work; for example, modelling the regenerative powers of animals after amputations and spinal injuries, or studying birdsong to better understand the production of human speech (pp. 245–265). We cannot showcase here the numerous examples of bioinspired designs to which Goldfield draws attention. However, the intelligent layperson is better served by far more accessible books on the subject.[7]

Science fiction or fantasy?

After further discussion of the ways in which biomimetics experts seek to emulate biological responses to congenital abnormality, pathology, and injury (which includes a brief treatment of rehabilitation robots and virtual reality; pp. 317–321), Goldfield concludes the book with his vision for how best to emulate nature in bioinspired technologies. As already mentioned, 'nature' is his secular substitute for the Creator. Even so, what principles can be gleaned by biomimeticists, whether they choose to credit the omniscience of God or do not (biological plagiarists)? Goldfield lists the following (pp. 373–374):

1. *Self-assembly*—at all scales, this is a feature worth emulating.
2. *Consortia*—try to build biological–synthetic devices from a consortium of interchangeable parts.
3. *Decentralized control*—use components which, hopefully, will collectively self-assemble into complex architectures.
4. *Flexibility with stability*—build devices from redundant components that, later on, can be quickly dismantled and reassembled for a different function.
5. *Emergent behaviour*—aim to have components, the individual specialized functions of which collectively exhibit complex emergent behaviour.

While Goldfield's *Bioinspired Devices* exposes the reader to many interesting attempts to follow these principles, the artificial instruments and interventions are exceptionally

modest when compared to 'nature'. For example, there have been striking strides forward in facial recognition and socially assistive robots, but the construction of a robot that could empathetically respond to injury or disease (let alone anticipate problems) remains science fiction. In spite of the impressive advances in computation, artificial intelligence, and robotics, real-world biology is still orders of magnitude more sophisticated.

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1. Johannes Kepler (1571–1630) is usually credited with saying: "I was merely thinking God's thoughts after him. Since we astronomers are priests of the highest God in regard to the book of nature, it benefits us to be thoughtful, not of the glory of our minds, but rather, above all else, of the glory of God."
2. The changing shape of an organism, morphogenesis, is affected by such things as mitosis (cell division), apoptosis (programmed cell death), cell shape alterations, cell movements, and cell interactions.
3. Tensegrity studies the way in which cell or tissue shape alters through the balance of forces of compression and tension. Tensegrity might help associate individual cell behaviour with collective cellular organization as tissue (p. 44).
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Humanity's future and AI—bright or Orwellian?

2084: Artificial Intelligence and the Future of Humanity

John C. Lennox

Zondervan Reflective, 2020

Philip B. Bell

John Lennox, Professor of Mathematics (emeritus) at Oxford University (figure 1) has written many books of interest to biblical creationists, such as his valuable *God's Undertaker: Has science buried God?*[1] Frustratingly, his adherence to deep time and concomitant compromise on the days of creation sometimes mars his writings.[2] Happily, this is not the case with *2084*.[3] Lennox tackles his subject with enthusiasm and his lucid and accessible writing style makes for an engaging read.

Without doubt, Artificial Intelligence (AI) is both a rapidly expanding field and a burgeoning industry: "between 2011 and 2015 China published 41,000 articles on AI, nearly twice as many as the US with 25,500", and in 2018, the UK signalled its intention to spend £1.3 billion, funding one thousand Ph.D.s in AI (p. 54).

However, AI is calculated to conjure up a multitude of images and ideas in people's minds, some positive but others quite negative. Is such advanced technology a cause for unbounded optimism regarding future human flourishing? Or else, should we be wary of the possibility of machines taking over our lives, even controlling us? What about the spectre of totalitarian states using AI to eviscerate citizens of their basic freedoms and human rights? Is the field of AI moving in a direction that is at odds with the teaching of Genesis 1 and related passages regarding the sanctity of human life? What about transhumanism?[4] Lennox does well in covering all these issues and more in 13 interesting chapters.

Parts of the book grapple with such weighty considerations as AI's intersection with human nature, morality, and ethics. Aside from the concern of AI potentially abetting power-hungry authoritarian governments, there is the consideration that such technological advances might one day be detrimental to overall human well-being. A 2016 study by the University of Oxford's Future of Humanity Institute concluded: "Overall, A.I. should be better than humans at pretty much everything in about 45 years" (p. 65). People wonder how long it might be before robots take over.[5]

Lennox has certainly researched his subject well. He references a wide variety of authors, some of whom he engages critically at length, notably Dan Brown (chapters 1–3) and Yuval

Noah Harari (chapters 6, 7, 9, and 11)—and to a lesser extent, Max Tegmark (chapter 7), John Gray, and C. S. Lewis (chapter 6).

A brave new world?

Lennox's book title is an obvious allusion to George Orwell's dystopian novel *Nineteen Eighty-Four* (published in 1949; figure 2). Many terms from that book have passed into common usage, such as "Big Brother", "doublethink", and "thoughtcrime", and this taps into the worrying prospect that AI might eventually be employed to control and subjugate the populace. Aldous Huxley's *Brave New World* (1931) was in a similar vein. So, Lennox begins his book here but he quickly moves the reader on, to consider much more upbeat associations and benefits of AI: computer algorithms for helping select the best applicant for a job, and AI applied to enhance the energy efficiency of buildings, improve cancer diagnosis, optimise galactic surveys, enable driverless cars, facilitate facial recognition, and so on (pp. 22–23). But are all these impressive results of machine intelligence really analogous to human intelligence? Many scientists are sceptical but popular-level writers and novelists are often less cautious.

Where did we come from? Where are we going? Lennox tackles these big questions of life by critiquing the fictitious professor Edmond Kirsch from the novel *Origin*, by Dan Brown. This AI expert 'solves' the problem of abiogenesis using virtual reality, but real-world expert chemists (such as James Tour of Rice University, Houston) are justifiably disdainful of such ideas.[6] Lennox shows that there is no getting away from the need for a Creator: "I put it to [Richard] Dawkins: 'You believe the universe created you. Who, then, created your creator?' I have waited over a decade and still no reply" (pp. 35–36). Dan Brown's Kirsch is intent on establishing science

Image: Christliches Medienmagazin pro/CC BY-SA 2.0

Figure 1. Christian apologist, John Carson Lennox

as a new religion; if only this were science fiction. Kirsch also employs AI to simulate humanity's future evolution—a strange 'post-biological' vision where humanity gets upgraded:

> "New technologies … will forever change what it means to be *human.* And I realize there are those of you who believe you, as *Homo sapiens*, are God's chosen species. I can understand that this news may feel like the end of the world to you. But I beg you, please believe me … the future is actually much *brighter* than you imagine [emphases in the original]" (p. 46).

Lennox suggests that Brown's character may have been inspired by Google's director of engineering, Ray Kurzweil. Kurzweil's book *The Singularity is Near* advances the idea that, maybe just 30 years from now, "AI robots will overtake humans in their intelligence and capabilities" (p. 44). But does that mean AI could develop a will of its own? The late Stephen Hawking thought so, but the likes of American business magnate Bill Gates and internet entrepreneur Mark Zuckerberg are sceptical of this Orwellian view, as are many neuroscientists for that matter (p. 49).

Narrow AI and artificial general intelligence

Lennox distinguishes between narrow Artificial Intelligence (what has actually been achieved) and artificial general intelligence (AGI), ideas of a higher-level fusion of humanity and machine, birthing a new form of life with unlimited potential. Many of the uses of narrow AI are uncontroversial. We are already familiar with digital assistants like 'Siri' and 'Alexa', real-time language translators, AI-enhanced medical diagnostics and surgical procedures, and autonomous vehicles (chapter 3). Other examples of the use of narrow AI require more wisdom in their implementation and certainly have their dark side; for example, in the job market (unfair discrimination during recruitment), in surveillance (especially its use in countries with 'anti-social' governments), in the production of military weapons, and transhumanism (chapters 5–6).

Leading players in AI do recognise ethical concerns (pp. 76–78) but these may fall short of those held by Christians for they are seldom founded upon the biblical teaching of the sanctity of human life. Atheistic assumptions feed a radically different view of humanity; Lennox quotes physicist Sean Carroll[7] from his recent book, *The Big Picture* (p. 98):

> "We humans are blobs of organized mud, through which the impersonal workings of nature's patterns have developed the capacity to contemplate and cherish and engage with the intimidating complexity of the world around us … . The meaning we find in life is not transcendent."[8]

Ostensibly, then, human cognitive abilities, however impressive, have sprung solely from evolutionary processes. So, with the benefit of foresight, we ought easily to achieve similar or better outcomes using AGI. Secular AI perspectives do tend to be overly optimistic or wildly imaginative. For example, MIT physicist Max Tegmark

envisages a powerful AI system called Prometheus which eventually manages and controls the entire planet—but is this perfect totalitarian regime really utopia? Lennox discusses this idea at length (pp. 105–111) but we will overlook it here because a detailed review of Tegmark's book, *Life 3.0*, was recently published in this journal.[9]

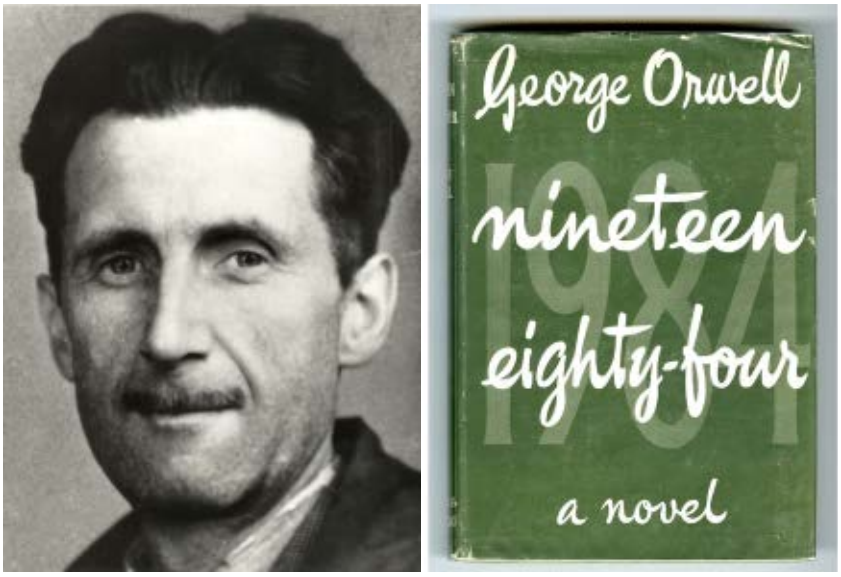

Figure 2. George Orwell's novel *Nineteen Eighty-Four* (1949) is a fictional, dystopian blend of politics and social science; the book cover is of the first edition.

A bright future for humanity?

The second half of *2084* (from chapter 8 onwards) shifts to a more biblical and theological focus. Lennox points out that AI is not entirely dominated by atheists and some of its thought-leaders are professing Christians; e.g. Donald Knuth and Rosalind Picard (p. 113). Much of what Lennox writes will have the biblical creationist nodding in wholehearted agreement, for example:

> "There is an irony here in that those who are seeking to create a superintelligence do not realise [refuse to believe] that there is good evidence that a superintelligence, *the* superintelligence, already exists: God the Creator and Sustainer of the heavens and the earth" (p. 117).
>
> "… you do not, in spite of what naturalism asserts, get from the inorganic to organic without an external input of information and energy from the Creator: 'And God said … .' Compare with this the goal of AGI to get from inorganic silicon to inorganic silicon-based life by *human* intelligent design" (p. 119).

Indeed, information can only arise from an intelligent source, so Lennox is quite justified in highlighting the disconnect in the minds of atheistic AGI researchers.

For many secular AI researchers, however, the sky is the limit regarding what human creators may achieve in future. But is it really likely that advances in AGI could one day lead to robots with the sort of aesthetic sense possessed by God's image-bearers, human beings? Or our sense of curiosity? People like Yuval Harari think so. He believes such features of high-level intelligence can be decoupled from consciousness.[10] However, as Lennox points out, the outworking of this could be rather grim, perhaps future techno-unemployment on a massive scale—something that would be wholly contrary to the biblical imperative of humans flourishing through gainful employment (pp. 128–130).

Lennox reminds readers of the foundational teaching of the Fall of Man in Genesis 3, then discourses on the implications of this for the ethical and moral evaluation of AI in our world today (chapter 9). There are some thought-provoking insights, such as:

> "The man and the woman who had enjoyed the joy and friendship of God now felt that God had become their enemy, and they fled to hide from him. We humans have been fleeing likewise ever since—a flight that bears within it all the seeds of dystopia. … Human history shows that we have used our autonomy to get out of control. That is exactly what drives the fears around AI. What if our creations get out of control? Will a superintelligent *Homo deus* do to the rest of us what we have done to God?" (pp. 142–143).

Quite. And what if AGI meant decoupling intelligence, not merely from consciousness, but also from conscience? That would lead to ethical decisions based upon moral relativism, which would surely be reflected in worrying ways in the AI machines of the future. Lennox convincingly shows that AI applied to morality is very dubious. For example, how could one programme a computer or AI-robot to avoid prejudice against people of a certain gender or 'race'? Lennox points out: "If things go wrong because the system amplifies the bias rather than removing it, we cannot blame the conscienceless machine" (p. 149).

Future shock

The final chapters of *2084* are strongly gospel-orientated. Firstly, *the true Homo Deus*, Jesus Christ, is shown to be the Superintelligence with whom every human being must reckon. Sinful rebellion against God brings the penalty of death, both spiritual and

physical. Moreover, physical death is not some technical problem that AI will eventually render obsolete; Christ's resurrection would otherwise become meaningless. Lennox ably employs Scripture (from both Testaments) to demonstrate the vast superiority of Christianity, to the credo of AGI popularisers, in terms both of salvation, and its vision of the future. For example, speaking of Jesus' ascension, Lennox says:

> "We pause to contrast this with the hope of AGI that one day we will be able to upload the contents of our minds onto silicon and so 'live' forever. Jesus' mind was not uploaded onto silicon; he ascended bodily into heaven. This claim clashes head-on with the dominant, earthbound, atheistic naturalism of the Western academy that teaches that this world is all that there is; there is no other world to which one can ascend" (p. 171).

Neither medical advances nor AI will avail in the face of death. Instead, human beings must all face up to the "future shock: the return of the man who is God":[11]

> "God, … the divine Logos who was in the beginning, has coded himself into humanity—the Word became flesh and dwelt among us. This is not artificial intelligence; this is Real Intelligence—way beyond anything conceivable, let alone constructible, by humans" (p. 187).

True, there are those who have sought to usurp God from his place, and they continue to do so; Lennox discusses in particular the 'man of lawlessness' (2 Thessalonians 2:3). Sadly, however, many human beings suffer totalitarian social control right now. It is not a nightmare from which they can wake up, but a present reality. In such countries, AI is already being misappropriated in ways that contravene basic human rights, and it is not fanciful to assume that this will continue. Is there any reason for human beings to hope for something better?

"How far will God permit humans to go?" Lennox answers his question, first by pointing out that God has intervened in judgement in the past (e.g. in Genesis 3, and at Babel), then by affirming:

> "According to the biblical narrative, God will intervene in the future to bring human rebellion to an end" (p. 203).

He posits possible interconnections between AI and eschatological passages of Scripture, such as those that many Christians understand as teaching a future one-world government. One may not share all of Lennox's thoughts about future scenarios, but they make for stimulating reading. He avoids dogmatism and advises that such things may lie in the far-distant future—in which case, of what relevance are such musings for us today? He points out New Atheist demagogues tenaciously seek to advance scientism, while denying that faith in God has any evidential basis. The way would appear to be open, then, for prominent godless individuals to use AGI to implement an atheistic agenda (p. 218).

In spite of the reality of endemic evil (whether in the human heart, or in government structures), Christians should not run and hide, but actively participate in society, embracing the positive aspects of artificial intelligence. In this way Christians should be model citizens, says Lennox, where possibly making positive contributions to narrow AI that will benefit others (p. 224).

In summary, *2084: Artificial Intelligence and the future of humanity* lives up to its title admirably and deserves to be widely read.

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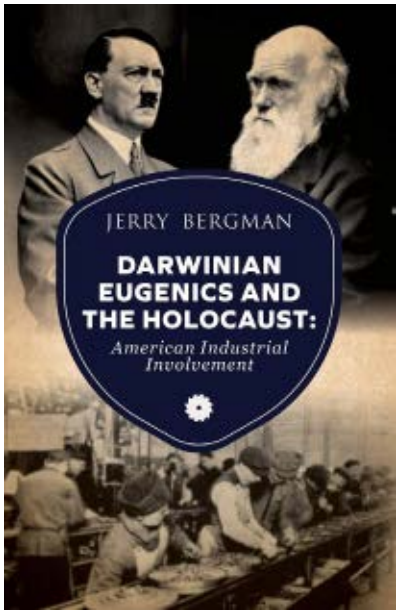
The deep and undeniable Darwinian roots of Nazi eugenics

Darwinian Eugenics and the Holocaust

Jerry Bergman

Institute for Science and Catholicism, Involgo Press, UK, 2020



John Woodmorappe

The Darwinian revolution changed not only our thinking about God and creation, but also about how different groups of people saw each other. The 'struggle for existence' that was part and parcel of Darwinism led people to think in terms of inferior and superior races. Such notions were actively promoted not only by the masses, but also by intellectual leaders. This book traces the ugly course of Darwinian thinking. It focuses on the many Darwin-inspired endeavours regarding 'scientific' racism, which culminated in German Nazism. The author also has a chapter on how American companies, such as IBM, were complicit in the success of Nazi Germany.

Author Jerry Bergman has nine degrees. He has taught a variety of scientific courses at several universities and has over 1,400 publications in both scholarly and popular journals. His works have been translated into 14 languages, and he has spoken over 2,000 times to college, university, and church groups all over the world.

Evolutionary theory was a big boon to racism

Defenders of Darwin remind us that racism existed long before Darwin. Yes, it did, but at nowhere near the intensity that it had after Darwin! Moreover, evolutionary theory endowed racism with the authority and prestige of science that it never had before. Author Bergman notes the statements of famous evolutionist Stephen Jay Gould:

> "As the late Harvard professor Stephen Jay Gould famously wrote in his book *Ontogeny and Phylogeny*, 'Biological arguments for racism may have been common before 1859, but they increased by orders of magnitude following the acceptance of evolutionary theory'" (p. 89).

'By orders of magnitude': That is saying it pretty strong.

Ian Thomson, who reviewed a book on the 19th century German genocide of the Herero and Nama peoples of present-day Namibia, did not hesitate to finger Darwin as the impetus behind modern racism and genocide. Bergman thus quotes Thomson:

> "'Darwin's *On the Origin of Species*, with its brutally materialistic account of nature as bleak survivalism, was made to serve as justification for the extermination of Namibian tribes and, later, for Hitler's biological anti-Semitism. In a racist age, nature was seen as a competitive market place, where black people were born to be mastered and the fittest survived'" (p. 41).

Darwin's champion, Ernst Haeckel, was strongly racist

The author elaborates on the fraudulent embryonic drawings of Ernst Haeckel, who was probably the most prominent champion of early Darwinism. Haeckel's drawings implied that, not only were blacks inferior to whites, but that blacks were closer to the higher apes than the whites. Bergman gives several examples of this.

In addition, Bergman reminds us that Haeckel's fraudulent drawings were long uncritically accepted as factual because they supported the evolutionary worldview:

> "Haeckel capitulated only in cases where far too many influential people judged his work as grossly inaccurate. Nonetheless, the exploitation of Haeckel's forgeries by Darwinists and by several science organizations was a major factor that spread widely both Darwinism and racism, not only in Germany, but also in the United States" (p. 35).

Understanding eugenics: effectively a speeded-up evolution

Author Bergman clarifies this matter:

> "The control method, called *Positive Eugenics*, involves coercing or bribing those judged more fit to produce more children, while those judged less fit are coerced or bribed to produce fewer children. Conversely, *Negative Eugenics* involves forced sterilization or other means

Figure 1. Margaret Sanger, the founder of Planned Parenthood, was entangled with Nazi German eugenicists.

of achieving the same goal, such as murdering those 'less fit' as done by the Nazis. According to a historian at the Ethics and Public Policy Center, Christian Rosen, Ph.D., the goal of eugenics is to move human evolution from the blind, slow process that nature achieved to the intelligent, deliberate, and purposeful guidance of evolution by intelligent, well-educated, humans" (p. 8).

Social Darwinism?

So-called Social Darwinism was not, as nowadays portrayed, some kind of misunderstanding of Darwinism. It was pure Darwinism—as understood by many educated people. This included Charles Davenport, a Phd from Harvard University, and Luther Burbank, the American agricultural genius.

Darwinism and eugenics go hand in hand

H.G. Wells was a major proponent of eugenics. His slide into eugenics was natural. Bergman writes:

"Wells and many others believed that one part of the solution to the problem that Darwin's theory of evolution had replaced the Divine Purpose by the process of natural selection was eugenics … . This goal was to be completed by 'death' or 'mercy killings' and Wells advocated that those involved in his eugenic world should have 'no pity' for the unfit … . His concern, as was Hitler's, was to control the 'laws of evolution so that mankind could become their master rather than their victim.'…Wells believed that evolution, when operating on its own, was not 'progressive', but needed to be 'directed' by the educational elite. This was exactly the view of the Nazi party" (pp. 74–75).

Inadequacy of theistic evolution

The experience of H.G. Wells is instructive. Raised a devout Christian, Wells became influenced by Darwin. He tried to reconcile his new evolutionary belief with Christianity, based on his mother's reassurances that 'somebody must have made it all', as well as Henry Drummond's work aggressively promoting theistic evolution. Wells saw through all of it. Bergman comments:

"One important reason the formerly devout believer became an atheist was, when he believed in evolution, he could no longer accept Genesis. He logically deduced that, if evolution were true, the basis of Christianity, including the Fall and the sacrificial death of Christ to redeem fallen humans, was all untenable. Wells concluded that Darwinism had dealt major blows to 'revealed religion but offered no spiritually rewarding alternative to it'" (p. 71).

Evolution as a weapon against God

Jerry Bergman focuses on the modern evolutionist Greg Graffin, a paleontology professor at the University of California at Los Angeles. Like Wells, Graffin had been a theist who converted to atheism as a result of evolutionary theory. Bergman writes: "Graffin recognized in his Ph.D. thesis that theistic evolution is an oxymoron, and that an irreconcilable contradiction exists between evolution and theism" (p. 18). Graffin was surprised to find that many evolutionists retained a belief in God, and concluded that these scientists were intellectually dishonest in hanging on to God. According to Bergman, Graffin concludes that these scientists "appear to be more concerned about remaining in the good graces of the public than they are about responsibly exploring the implications of their [evolution] worldview" (p. 18).

The Nazis relied on the eugenic policies of the USA

Bergman details the ways that the Nazis admired and imitated American eugenicist thinkers. For instance, Madison Grant (1865–1937) warned against the American Nordic population becoming polluted by inferior races. Grant was strongly endorsed by leading American biologists, notably the later president of the American Museum of Natural History, Henry Fairfield Osborn, Sr (1857–1935).

American immigration laws, designed to screen out 'inferior' races, became a model for the Nazis in dealing with Jewish refugees. Laws against 'race mixing' in the USA were explicitly copied by Nazi Germany. All this was rooted in evolutionary theory. In fact, Bergman writes:

"Werner Maser, who compiled the book *Hitler's Letters and Notes*, concluded from his compilation that 'Charles Darwin, one of Hitler's 'teachers' … readily adopted his idea of survival of the fittest" (p. 2).

This had practical consequences. Ernst Rudin (1874–1952), who was Hitler's director of eugenic sterilization, published articles in *The Birth Control Review*. This journal was edited

by none other than the American Margaret Sanger (figure 1), the founder of Planned Parenthood (p. 177).

U.S. Supreme Court justice Oliver Wendel Holmes became an enthusiastic supporter of eugenics. He once said that "Three generations of imbeciles are enough", and Bergman notes that "Justice Holmes' now-infamous summing-up of the case was later quoted by the Nazis to defend themselves in front of the American judges presiding over the Nuremberg war trials" (p. 65).

Nazism was left-wing, not right-wing

Bergman probably ruffles some feathers in making the following comments:

> "Politically, the Nazis were generally left, as documented by *New York Times* best-selling author Dinesh D'Souza. A key doctrine of socialism is 'social justice'. Hitler even used those exact words in *Mein Kampf*. Group punishment (identity politics) is another key doctrine of socialism. If the Jews were the cause of social *injustice* in Germany because they dominated or played a significant role in German professions, finance, business, and culture from about 1820 to 1930, and thereby denied Germans access to these benefits, social justice demanded that they pay reparations to 'der Volk'" (p. 4).

Modern manifestations of Darwinian eugenic-style thinking

Bergman points out that the ugliness of Nazism discredited Darwinian eugenics, and the 1960s civil rights movement put an end to 'scientific' racism. However, this does not mean that eugenics is only of historical interest.

Paul Bowman Popenoe (1888–1979), the coauthor of the widely-used *Applied Eugenics*, therein expressed admiration for the ancient Spartan and Roman practice of letting weak or imperfect infants die (p. 162). That was then and this is now. Abortion, apart from summarily denying the humanity of the unborn child, has nowadays been used to subtly 'improve the human race'. Jerry Bergman comments:

> "We claim eugenics is dead, but the 'new-genetics' is now very popular in the West. New genetics are trying to achieve human perfection by 'D-Selection'. An example is 'nearly 2,300 abortions of fetuses with mental and physical disabilities were carried out in the UK alone in 2010', showing that it is all too easy to be again seduced down the Nazi route" (pp. 182–183).

Conclusion

Darwinian evolution has a dark past that many evolutionists would like us to forget about. Its appearance in the 19th century spawned a range of 'scientific' racist theories that were taken very seriously, which caused great harm to people, and which culminated in Nazism in the 20th century. Although racism is nowadays supposedly discredited, the Darwinian notion of 'a struggle for existence' lives on in more subtle fashion, and is manifested in such things as the abortion of mentally-handicapped children.

Hans and Sophie Scholl, who went to the guillotine for their defiance of Nazism, chided German Christians for their apathy and inaction in the face of evil, "What did you do about it?" (p. 181). The challenge lives on for Christians in the West today.

The Tasaday Stone Age people hoax

Jerry Bergman

The story of the Tasaday hoax is reviewed to help explain why so many people accepted a claim for so long of an event that turned out to be a hoax. Although termed a tribe, the Tasaday in the reports that received much of the media coverage involved only a couple of dozen of people. How the hoax was exposed, and the likely motives behind it, including money, fame, and academic prestige, are also dealt with, as is the lesson the hoax provides for us today, relative to Darwinism, including the problem of ignoring clear evidence that this group are not a Stone Age people as commonly represented. The example also illustrates the tendency to see what one wants to believe. The case also illustrates the complexity of hoaxes and the different reasons that the people involved perpetuate them.

The Tasaday were presented to the world as a 'Stone Age' tribe living in caves in a rainforest for over a thousand years until their isolation ended when a hunter from a neighbouring tribe stumbled onto them while setting hunting traps. This hunter mentioned their existence to Harvard-educated Manuel Elizalde Jr, who at the time was an adviser to President Ferdinand Marcos on the subject of Filipino minorities. Intrigued, in June of 1971, Elizalde chopped his way into the jungle on the southern island province of Mindanao in the Philippines, to meet these Stone Age people in an effort to learn how he thought primitive humans once lived back in early human evolutionary history.

Elizalde claimed he learned from the tribe members that they used "only the most rudimentary Stone Age tools, scraping a meager living from the rain forest. They had no agriculture, no cloth, no weapons, not even domestic animals," nor art, music, pottery, or metal tools and wore sparse clothing made from fresh leaves. They even lacked spears, or weapons of any type, including bows and arrows, to use to hunt.[1] They lacked formal trade networks or regular contacts with the outside world, "living in almost total social and geographic isolation"[2] for probably over a thousand years.[3] Their only tools "were made of edge-ground stone, a type of implement dating back more than six thousand years."[4]

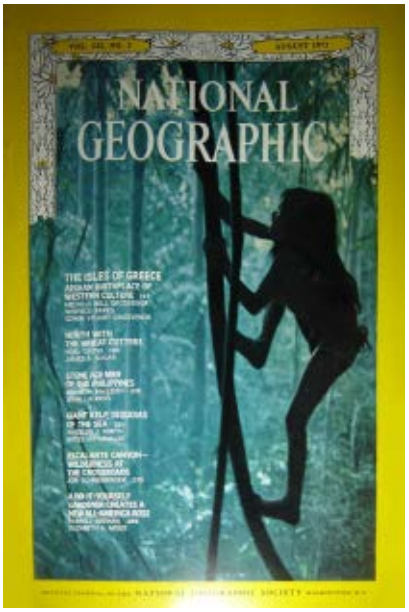
Their whole world was their small corner of the forest. They had no word for, nor had ever seen, the ocean or even a boat, although the ocean was only a few miles away from their home. Their life involved them being "squatted in caves wearing G-strings of leaves … [dining] on grubs, roots, and wild fruit, especially wild yams scraped from the jungle soil."[5] They were described as living in a very early, long-past "evolutionary phase" and were "distant relatives of Java man and Peking man … the first true man in the evolutionary process, who walked the earth more than half a million years ago."[6] Or so the story went … which story eventually was completely debunked.

Not long after the find was announced, anthropologists, researchers in human evolution, and reporters were flying in on helicopters in an attempt to visit the Tasaday's jungle home to see for themselves how humans lived "a hundred centuries ago" before we humans allegedly evolved beyond the Stone Age.[7] The famous pilot Charles A. Lindbergh described his visit to the Tasaday as being like visiting his "ancestors a hundred thousand years ago."[8] Competition among the "journalists and anthropologists for access to the Tasaday became a source of professional friction."[9] The reason for the excitement was that the Tasadays "provide an unparalleled opportunity in the twentieth century to understand more fully man's culture and behavior before the appearance of agriculture and the domestication of animals", before the evolution of modern man.[10]

As a result of this opportunity to better understand primitive people and human evolution, the Tasaday went from being an unknown people to an internationally famous tribe. Pictures of their dirty faces posing nude in their rocky caves soon appeared in magazines throughout the world. One anthropologist dubbed them "paleohippies".[11]

Documentaries soon aired on TV, a Tasaday child climbing vines graced a *National Geographic* cover (figure 1), and NBC News gave Elizalde 50,000 dollars to do a documentary on the Stone Age tribe, which was actually not a tribe, but closer to a family of two dozen people. The *National Geographic* issue on the tribe was "one of the magazine's best-selling issues in its history."[12] Thick books backed up by hundreds of footnotes were written about them, including a bestseller by John Nance titled *The Gentle Tasaday* (figure 1). Soon even linguistic studies of their language were begun. The scientists touted that we now had living proof of human evolution from our early primitive-caveman, Stone Age ancestors.

The shy Tasaday's 'peacefulness' also captivated the world. Some who studied them even claimed the Tasaday lacked words for 'war', 'enemy', or even 'conflicts'. They were an uncorrupted version of a rainforest Garden-of-Eden humanity. Their presumed gentleness in 1971 greatly



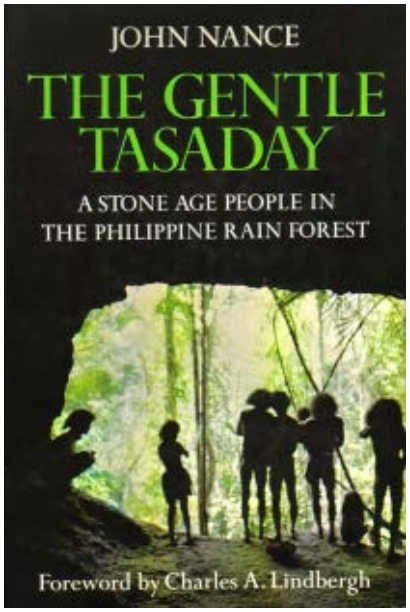


Figure 1. Left, the cover of *National Geographic*, August 1972; right, the cover of *The Gentle Tasaday*, supporting the Stone Age tribe theory

contrasted with the images of violence and horror then daily coming out of the Vietnam war.

The press presented the story as a validation of human evolution. Here was a preliterate tribe living without clothes in a cave, unchanged for thousands of years, that functioned as a time capsule to give scientists a glimpse of life long before civilization appeared on Earth.[13] For evolutionists, it was a picture of the way primitive humans once lived, a compelling snapshot of life at an early stage of human evolution, and a much better picture than any set of fossils could ever depict.

About this time, the close association of the Tasaday with Manuel Elizalde Jr began to cause problems. After Elizalde was appointed their protector, he tightly controlled access to them. Elizalde was a wealthy man with numerous business interests and lofty political ambitions. Although living a jet-setting life, he promoted himself as a champion of tribal minorities. The tight rein he had on access to the Tasaday angered many. Elizalde even persuaded Philippines President Ferdinand Marcos to declare the Tasaday's rainforest area a protected reserve. "This policy, not coincidentally, also served to isolate them from those whose only agenda was to study them."[14] Some observers correctly surmised that Elizalde was exploiting the Tasaday to further his political ambitions.

The Tasaday story unravels

Unfortunately, most visitors from the outside that came to "observe the Tasaday were carefully supervised and [the visits were often] brief, usually less than two or three hours, ostensibly to ensure minimal" contaminating influence by outsiders. The supporters of the tribe claimed their concern was that outsiders would corrupt the naïve native people.[9] Some anthropologists, such as Daniel Stiles (Ph.D. in anthropology, University of California, Berkeley), found their attempts to do field work with the Tasaday tribe people stymied.[15] Professor Stiles had made all of the arrangements to visit the Tasaday tribe but was "blocked at the last minute", one suspects due to fear that the hoax proponents would be exposed.[16]

"[I]n 1986, this neat little scenario [the Tasaday Stone Age tribe hoax] came crashing to earth."[11] The Marcos government was overthrown, and the Tasaday Stone Age people were again accessible to outsiders. A Swiss journalist with a doctorate in anthropology, Oswald Iten, accompanied by a Filipino reporter, seized the opportunity to find out what had become of the earth's only living Stone Age people during the last 15 years. What they found shocked them, and soon became the basis for the conclusion that the entire Tasaday story was an outrageous hoax "equivalent to the fraudulent discovery of Piltdown fossils earlier in the century in Britain."[17]

The team found the Tasaday's caves empty, the same caves that the Tasaday had assured the world that they had lived in "always. Our father's father and his father were there".[18] The two dozen Tasaday were now living in clean huts among the Blit Manubo tribe. Gone were their dirty faces. They were neatly dressed in stylish slacks, jeans, and t-shirts, wearing jewellery and colourful scarves, living a simple, but not by any means primitive, lifestyle (figure 2).[19] They grew crops, lived in huts and slept on wooden beds.[20] Either they had amazingly rapidly both learned and adapted to modern culture, clothing, jewellery, and habits including cleanliness, or had taken part in an elaborate hoax that fooled the world

The cavemen story turned out to be very naïve

Most anthropologists agreed that, in order to sustain themselves as a separate group, it would have required at least 400 individuals, not around 24, which would also serve in helping to avoid incest, a powerful Tasaday taboo. Furthermore, a tropical rainforest offers very little for humans to eat. Even the most primitive jungle diets must be augmented with some cultivated food. They could not have survived for very long on the diet which they claimed they survived on for generations.[21]

A survey of their claimed cave-home areas also revealed no evidence of long-term habitation, such as a significant level of garbage, or even evidence of long-term fire usage. This evidence would be very obvious if they had lived in the caves for centuries as they claimed. In short, acceptance of the cave story was largely because the anthropologists and evolutionists wanted to believe it, but when they began looking into the story in more detail, it very quickly fell apart.

The hoax unravels

Upon questioning, two Tasaday admitted they were not a Stone Age tribe and never had been. They claimed that Elizalde had pressured them into posing as one, claiming:

> "We didn't live in caves until we met Elizalde. … Elizalde forced us to live in the caves so that we'd be better cavemen. Before he came, we lived in huts … and we farmed. We took off our clothes because Elizalde told us to do so and promised if we looked poor that we would get assistance. He gave us money to pose as Tasaday and promised us security from counter-insurgency and tribal fighting."[11]

Judging by their dress that Iten observed, their acting performances paid off handsomely.[19]

Iten's discovery sent shockwaves around the world—a fake Stone Age tribe that had managed to fool even the most experienced authors and anthropologists. An example of where anthropologists had been fooled by the hoax is a *Current Anthropology* magazine article that discussed the Tasaday. It uncritically assumed that the Stone-Age-tribe claims were completely legitimate, even though from the first reports problems would have been noted by critical readers.[22]

Reporters were again making the journey into the Filipino rainforest to visit the Tasaday, only this time for other reasons. A group of German journalists arriving within days of Iten's departure found the Tasaday back at their caves dressed in leaves. But the Germans noticed cloth garments peeking out from beneath the Tasaday's tactfully placed leaves. It turned out the Tasaday, caught unawares by Iten, had hastily decided to resume the 'Stone Age tribe' act, but weren't sophisticated enough to pull it off without outside help. Consequently, they had pulled on their leaf cover over their clothes.

Researchers now realized there were many unanswered questions about the Tasaday. At the least, the claim that the tribe's "discovery had been staged and scripted by the government of President Ferdinand Marcos cast serious doubt on its authenticity."[23] Was it believable that the Tasaday were isolated for a thousand years, given they lived only a few miles away from a nearby village? Why did the Tasaday appear to be resistant to modern diseases, a problem because their isolation would have left them with little resistance to diseases, a condition which the South American Indians were in when the Spanish arrived many years earlier? Why had Elizalde so tightly controlled outside access to the tribe? And why, if they lacked knowledge of the use of steel, did many of their instruments and utensils appear to have been cut with steel knives? One study by anthropologist Gerald Berreman of the stone tools the Tasaday claimed to use in order to survive concluded they were nonfunctional and amateurish like "seventh graders might be expected to invent in response to a classroom assignment".[24]

Faced with these questions, and armed with confessions from the Tasaday themselves, "The accumulated evidence … left little doubt among many in the academic community that the entire Tasaday episode was a deception perpetrated by political actors, led by Elizalde."[25] They also concluded the Tasaday story was a hoax dreamed up by Elizalde to make money, now estimated to be more than 35 million dollars.[26] This judgement was expressed in documentaries about the Tribe, such as *Scandal, the Lost Tribe* and *The Tribe That Never Was*.

The revenge of the Tasaday

However, the Tasaday still had friends (Elizalde, in particular) who attempted to repair the tribe's now battered reputation. Despite Marcos's overthrow, Elizalde wielded enough influence in the Philippines to mount a vigorous pro-Tasaday campaign. He led the defence of the Tasaday when the Philippine Congress investigated the hoax claims in 1987. The Congress eventually decided that the issue of fraud should be left to the scientists, not politicians.

In 1988, Elizalde flew some Tasaday tribe members to Manila to file a lawsuit against the Philippine professors who were calling the 'Stone Age' claim a hoax. The Tasaday then became the first Stone Age tribe to sue for libel! These efforts paid off when, also in 1988, the new Philippine president, Corazon Aquino, declared that the Tasaday were a "legitimate Stone Age tribe".

These political tactics had little effect on scientific opinion. Some things about the tribe were proven to be true. For example, evidence exists that the tribe did live as isolated nomadic hunter-gatherers until 1971. While it is true that a detailed examination of their language by linguist Clay Johnson, who had lived with a neighbouring tribe for 10 years, concluded that the Tasaday language was "virtually identical to that of their neighbours",[21] it nonetheless appears to have been in some ways distinct. Linguists came to believe it likely split from the language of the nearby Manobo people around 200 years ago.[27] Fieldwork, such as by Lawrence Reid of the University of Hawaii, who lived with the Tasaday for extended periods throughout the 1990s, identified their language as a dialect of Cotabato Manobo.

Reid also concluded that the Tasaday had not been isolated for a thousand years but likely had splintered off from the

Figure 2. The Tasaday tribe taken in front of their home territory. Photo by Susanne Haerpfer taken in 2012. Not many females are pictured, and six children are included.

Cotabato Manobo community a few years ago, perhaps fleeing into the jungle to escape an outbreak of disease.

In addition, the tribe had frequently made contact with neighbouring tribes, and through this contact acquired steel tools and learned agricultural skills. Consequently, when the outside world discovered them in 1971, they were definitely not an isolated Stone Age tribe as first claimed. However, they were living in what we would term primitive conditions, as were many tribes in this and other countries, such as some tribes in the Amazon in the late 1960s.

Supporters of the Tasaday still had to account for the Tasaday's confession that they were a hoax. Then two Tasaday claimed that they had made up this confession because they had been bribed. Friends of the Tasaday credited this confession to the anti-Marcos sentiment that ran high in the Philippines in 1986. Since the Tasaday had been considered a showpiece of his regime, a means by which he projected an idyllic view of the Philippines to the outside world, they became a target of choice for Marcos's detractors. Furthermore, if the Tasaday Stone Age claims were deemed a hoax, the tribe's rights to the reserve that protected their land would vanish, and the loggers could move in.

Making sense of the Tasaday

At the least, Elizalde was guilty of having encouraged the Tasaday to try to look *more* primitive for the benefit of the cameras. He asked them to wear leaves and hide their steel tools. Thus, he distorted the truth, as did the Marcos government, which shamelessly promoted the Tasaday as a quaint symbol to showcase an idyllic and exotic view of the Philippines.

However, the Tasaday themselves appear to have willingly played the role asked of them. They liked the attention and hoped that Elizalde would provide them with significant financial aid, which he did. The fact that they were wearing nice clothes including jeans and t-shirts when Iten found them is hard to explain just by the 15 years of acculturation they had experienced since 1971. There was also a surreal moment in 1988 when members of the Tasaday agreed to participate in a cultural festival at nearby Lake Sebu, during which they posed in imitation caves, like exhibits in a zoo, for the benefit of onlookers.

The media also repeatedly misrepresented the Tasaday. In 1971 it hyped them as a peacenik, utopian, Stone Age tribe. It could only see the Tasaday in sensationalistic black-and-white terms, as either throwbacks to the Stone Age, or a fraud, never in shades of grey. Almost everyone involved in the Tasaday story distorted the truth for their own purposes. The supposed evolutionary discovery was so "transparent and compelling it … was not strictly speaking, dependent on the *truth* [emphasis in original]."[28] In the end, most of the claims about the tribe's primitiveness were documented to be, at best, gross exaggerations, or errors.[29]

Understandably, "Appalled by the apparent humbug that had taken in so many, including most anthropologists, the American Anthropological Association asked linguist Thomas Headland to organize a symposium on the Tasaday for their 1989 annual meeting."[21] The contributions, which were published in 1992, found that of the participants, "most concluded from the evidence that the Tasaday had been manipulated to play the role of a primeval cave people as part of a cynical hoax."[21]

The media completely sold on the Stone Age tribe myth

A major question that arises is: "Why were Westerners, and Americans in particular, so willing—and even eager—to embrace the Tasaday [hoax]?" "Why were we so fascinated with the notion of noble primitives? They never hold up under scientific scrutiny."[30] The answer can be found from reading the many publications about the Tasaday, mostly articles supporting evolution, in this case evolution from primitive cavemen to modern men. The best illustration of the fact that the media was completely sold on the 'Stone Age tribe' myth was the example of *National Geographic*,

which published two gullible articles on them, but subsequently gave no hint that their story had been irresponsible.

One of these two accounts described their Stone Age hardware as so primitive that, "For the Tasadays, the height of technological sophistication has been a knife with a bamboo blade or a hammer of chipped stone bound with rattan to a wooden handle."[31] The story also claimed they used crude digging sticks, stone scrapers, bamboo knives and had no word in their vocabulary for 'war' as we would expect from self-respecting cavemen. The magazine even added that the Tasaday described some of their visitors as "strangely clad men from the sky, bearing miraculous gifts—beads, mirrors, metal knives, even a flashlight."[32]

The anthropologists, the *National Geographic* added, had long been looking "forward to the rare opportunity of studying firsthand a people who ... have lived in isolation for hundreds of years" or longer. The three-page article had three illustrations of nude 'primitive' men, women, and children doing caveman things with primitive tools.

The *National Geographic* follow-up, a 30-page article that contained 19 pictures of nude men, women, and children, likewise had the Tasaday doing what you would expect Neanderthal cavemen would do. The Tasaday were very dirty, unkempt with long straggly hair, many sitting naked on rocks in barren rocky caves in a picture that looked staged; and, from what we know now, most of the posed photos and activities likely *were* staged for the camera. The rugged mountainous area shown in the pictures was described as "a primeval Eden" inhabited by "24 people who lived much as our ancestors did thousands of years ago."[33]

The children looked like they had mud smeared on their faces just for the picture, which is likely what occurred. One young boy was shown "climbing vines ... with the ease of a monkey ... . His major worry was lack of a mate. Only five of the Tasadays are women, and all have husbands."[34] We later learned one Tasaday man had two wives.[35] I counted nine children in one picture alone. The rest of the tribal people shown were young adults, and I saw no elderly adults in any of the pictures. This fact was explained by claiming their life span was very short, even though the researchers saw little evidence of disease.[36] In the distant past, a smallpox epidemic evidently occurred, but other than this they were very healthy. As noted, 24 people sheltered for thousands of years would have required almost all of them to be involved in incest, a practice apparently forbidden among these people.[37]

Now we know they found wives among nearby tribes. The person who discovered the Tasadays was, the National Geographic claimed, greeted as the "fulfillment of their ancestors' promise"[38] of a saviour that would come down from the sky (in this case a helicopter they called the "Big Sacred Bird").[39] This outsider would come to love and protect them, and lead them out of darkness. Their saviour was recognized as Manuel ('Manda') Elizalde.

A *Time* magazine article indicated that the Tasaday were "the most primitive human beings so far discovered on this guilty planet", adding that, to study these "prehistoric people", several dozen "scientists and journalists and film people" visited the Tasaday.[40] One example of the work of the "film people" is the *National Geographic* video special titled 'The Last Tribes of Mindanao'. The *National Geographic* also "published a cover story with dramatic pictures" about the Tasaday.[41] The hoax was also represented as fact in major encyclopedias and references books. Feder concluded that the "motivation for the hoax, [was] likely … to control and to profit from … a gullible world."[21]

Summary

As concluded by University of Chicago anthropologist Fred Eggan, the claim "That the Tasaday were an isolated Stone Age people is nonsense".[42] Instead, they were very poor people living close to nature in a Philippine jungle who became swept up in, and manipulated by, global events beyond their control. This version of events isn't as compelling as the versions that made headlines in 1971 and 1986, but is a good illustration of how the truth is often more complicated than it at first appears.

Although proving evolution was not the main motivation of the hoax, evolution was nevertheless a major reason why the hoax was uncritically accepted for so long in spite of the irredeemable problems with the original story. It is also a reason why it was so widely repeated as fact in so many sources, including mass media publications, references books, and encyclopedias. It also may explain why almost every USA publication that covered the Tasaday hoax, including the *National Geographic* and the *New York Times,* not only did not print a retraction after it had been exposed, but "actively upheld the old story" that claimed the Tasaday were a Stone Age Tribe isolated for generations.[43] The fact is, the claim of "The discovery of an isolated primitive tribe living in forest caves on the southern Philippine island of Mindanao in 1971 has become a disputed milestone in the history of cultural anthropology."[17]

It is true that the myth was finally exposed, but, in the end, not by Darwinists attempting to critically research the story, but more by those interested in harvesting the lush valuable wood where the Tasaday people resided. The Tasaday hoax even earned a place in *The Encyclopedia of Hoaxes*. The editor, after listing five convincing reasons to classify the Tasaday event as a hoax, wrote in his conclusion that the Tasaday affair was an outright hoax similar to the Piltdown hoax.[44] In the end, the Tasaday people

"… admitted to being members of a nearby tribe

> with normal human vices, who had been recruited for the greatest ever anthropological fraud (more than comparable with Sir Cyril Burt's doctoring of data on inheritance of intelligence within psychology). In recent years the continuing controversy between Tasaday's defenders and detractors has wreaked havoc inside anthropology, with scientific reputations at stake—if not a whole world-view, or even the credibility of science itself."[45]

Part of the problem is that "anthropology fieldwork produces 'fictions' that are vulnerable to criticism like any other work of literature."[46] As concluded by the British Broadcasting Corporation documentary *Tasaday, Trial in the Jungle,* if a group of 24 people were able to have "pulled off the most elaborate hoax in scientific history ... [and] fool every anthropologist who ever saw them, how credible is the science of anthropology?"[28] Actually, most, but not *every* anthropologist was fooled. Although many wanted to believe the Stone Age story, after the 1986 Iten report was published, anthropologists for the first time began to study the Tasaday claims in earnest with a skeptical eye, and when they did this, even they were surprised by how inept the hoax was, and how gullible they had been to accept it as valid.

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Research has overturned endosymbiosis: the unbridgeable gap between prokaryotes and eukaryotes remains

Jerry Bergman

Cells are divided into two major groups: prokaryotes (i.e. without organelles) and eukaryotes (i.e. with organelles). Evolution postulates that prokaryotes evolved into eukaryotes. An enormous gap exists between these two cell types that could not have been bridged by transitional forms. The most popular effort to explain this gap is the endosymbiosis theory of Lynn Margulis. The proponents' theory proposes some proto-eukaryotic cells engulfed prokaryotes, and eventually the engulfed proteobacteria evolved into organelles in the primitive eukaryotes. The many major problems with this theory are reviewed, leading to the conclusion that it is widely accepted only because it is the most plausible evolutionary hypothesis and not because of empirical evidence. In fact, as documented in this paper, considerable evidence exists against the endosymbiosis theory.

Understanding the "evolution of eukaryotic cellular complexity is one of the grand challenges of modern biology."[1] Unlike prokaryotes, eukaryotic cells are highly compartmentalized and contain many different membrane-bound organelles that are absent from bacteria or archaea (non-bacterial single-celled prokaryotes). Along with many genetic and molecular differences, complex compartmentalized organelles are not found in prokaryotes. Evolutionists generally attempt to explain how this happened by endosymbiosis, claiming that an ancient archaean engulfed a proteobacterium that eventually gave rise to the first organelle, a mitochondrion.

Endosymbiosis is a phenomenon where one creature lives inside another in a mutually beneficial relationship, such as is observed in the case of certain bacteria that live inside termites, for example. In this paper, 'endosymbiosis' will refer not to such observed phenomena, but to the widely accepted hypothesis by the late Professor Lynn Margulis (figure 1) to explain the origin of mitochondria, which is the focus of this paper (sometimes referred to as 'primary endosymbiosis'). It is invoked in an attempt to bridge the gap existing between cells lacking compartmentalized organelles (prokaryotes) and those with them (eukaryotes). Of course, the differences are much more than just mitochondria. Some of the other organelles a eukaryote has in contrast to prokaryotes are a nucleus, nucleolus, rough and smooth endoplasmic reticulum, Golgi apparatus, centrioles, peroxisomes, and lysosomes.[2]

At some point in the distant past, this endosymbiotic theory states, a prokaryotic bacterium engulfed a theoretical proteobacterium which remained inside of the host in a symbiotic relationship. That means that hundreds of genes were somehow modified to completely new functions. Additionally, the theory suggests that thousands of genes from the proteobacterium were transferred into the protoeukaryote cell's nucleus as many other genes were discarded.

The prokaryotic-eukaryotic DNA chasm

Prokaryotes contain a single circular DNA molecule that occupies the nucleoid region and often also small rings of double-stranded extrachromosomal DNA called plasmids. Prokaryote DNA is "profoundly different from eukaryotes" that contain "two to four separate and independently transmitted nuclear, chloroplastic, microtubular, and mitochondrial DNA genomes".[3] The prokaryotic–eukaryotic contrast is so great that it constitutes "'the greatest single evolutionary discontinuity' of life" known, and the "origin of eukaryotes has remained one of the most enigmatic, controversial and challenging questions in evolution."[4] Only two naturalistic theories of organelle evolution remain; all others have been effectively refuted.[5]

The first theory is the autogenous 'self-generated' hypothesis, which postulates that organelles evolved gradually from some precursor organelle by natural selection of mutations. This view lacks evidence for all existing organelles, and consequently has largely been rejected and replaced with some form of endosymbiosis.

The second theory is endosymbiosis, also called serial endosymbiosis theory (SET), symbiogenesis, or the *xenogenous hypothesis*. The enveloped bacteria (figure 2)

Figure 1. Late evolutionist professor Lynn Margulis (1938–2011), advocate of the faulty endosymbiotic hypothesis of the origin of eukaryotes

subsequently evolved inside their hosts to gain specialized functions, some becoming mitochondria (figure 3) that eventually took over the role of providing energy by 'charging' ADP to ATP. This occurs by way of the ATP synthase enzyme, a molecular 'machine'in both eu- and prokaryotes.[6] Prokaryotes are single-celled microscopic organisms that have far lower energy requirements than eukaryotes.

The ATP synthesis machinery in a prokaryote is embedded in its cell membrane, which would have been the case for the engulfing bacterium, which as at this stage in the theory still a prokaryote. In contrast, eukaryotes use mitochondria to charge ADP, so when the ancient archaean supposedly engulfed a proteobacterium which would eventually become a mitochondrion, it still had to meet its energy needs while evolving from a prokaryote to a eukaryote. Furthermore, only a "small fraction of the proteins required for the propagation and function of mitochondria are coded by their genomes, while nuclear genes code the vast majority."[7] The heart of the endosymbiosis explanation for the chasm between prokaryotes and eukaryotes is mitochondrial DNA.

From endosymbiosis to multicellular organisms

It has been long recognized that "The principle of endosymbiosis was suggested more than a century ago but was generally considered as 'entertaining fantasy'."[8] This view largely held until the work of Lynn Margulis, who developed the endosymbiosis idea in great detail.[9] Through her work and influence, endosymbiosis has moved from an obscure, poorly accepted idea to the most popular theory of organelle origins today.[10]

The common endosymbiosis scenario postulates that free-living eukaryotic cells eventually joined in communities now called multicellular organisms.[11] Problems were encountered soon after the endosymbiosis theory was proposed. For example, further research found that the mitochondria of fungi, plants, and animals were so different that endosymbiosis must have occurred independently many times, which only multiplies the highly improbable odds of the endosymbiotic scenario occurring even once.[12]

Margulis predicted that mitochondrial DNA will be different from nuclear DNA, but instead will consist of admixtures of sequences from eubacterial and archaeal genes.[13] In 1963, mitochondria were found to possess DNA independent of nuclear DNA.[14] Another important factor supporting endosymbiosis was the 1960s discovery of plastid DNA (cpDNA) in the chloroplast of plants called the plastome, which supporters argued made the endosymbiosis mechanism for the origin of organelles more plausible.[15]

The organelles called mitochondria are commonly "believed to have arisen only once in evolutionary history, but despite their common ancestry, mitochondrial DNAs vary extensively throughout eukaryotes in genome architecture and gene content."[16] Researchers have found that the largest mtDNA is in a freshwater protozoan, *Reclinomonas americana,* which has 69,034 nucleotides and 97 genes that encode 67 proteins, which includes at least 18 proteins not previously known to be encoded in mitochondria.[17] Endosymbiosis must, therefore, postulate that the engulfed bacteria lost 96–99% of their proteins, from ~1,600 down to below 67, depending on the specific engulfed protobacterium. For humans, only 37 genes are essential for cellular respiration.

Furthermore, comparisons of eukaryotic proteins in eukaryotic organelles has found they are not simply admixtures of sequences from archaea and eubacteria as endosymbiosis predicts, but are often unique, inconsistent with the idea that eukaryotic genomes are a combination of eubacterial and archaeal genes.[18]

All other examples examined also show major differences between mitochondrial and bacterial genomes, as expected given the protein differences described by Kirkland in a previous paragraph. Even for the best-known example (*R. americana* mtDNA), enormous differences exist between its 69-kbp (97 genes) and both the 580-kbp genome (470 genes) of *Mycoplasma genitalium* and the 1,830-kbp (1,743 genes) *Haemophilus influenzae* genome. Furthermore,

> "Comparison of the *Mycoplasma* and *Haemophilus* genomes suggested that their different gene contents reflect 'profound differences … between these two organisms' … . In this context, the *Reclinomonas* mitochondrial genome may be viewed as an extreme example of eubacterial genome reduction, such that

> the only genes remaining are related to mitochondrial gene expression (transcription, RNA processing and translation) and biogenesis of the protein complexes required for electron transport and coupled oxidative phosphorylation (including components implicated in mitochondrial protein transport and biosynthesis)."[19]

In short, these few examples illustrate the chasm existing between bacterial DNA and mtDNA which is only one of many problems with endosymbiosis.

Similarities and differences between mitochondria and bacteria

The endosymbiotic theory relies heavily on homology between organelles and bacteria. For example, each mitochondrion has a circular genome like bacteria, but much smaller and lacking histone proteins. The mtDNA is usually located in the mitochondrion's matrix, although it is sometimes attached to the inner mitochondrial membrane.

Mitochondria also closely resemble purple-aerobic bacteria in size and shape. They both use oxygen in ATP production using the Krebs cycle. Certain antibiotics that kill bacteria also inhibit mitochondrial functions. These general similarities alone do not demonstrate endosymbiosis because, as documented below, many significant, often major and critical, differences exist.

One factor arguing for endosymbiosis is membrane composition. The outer membrane of both chloroplasts and mitochondria has both structural and chemical similarities to the prokaryotic cell membrane. Later research, though, determined that mitochondrial membranes are only superficially similar to prokaryotic cell membranes. One difference is that the proteobacterium alleged to have entered the protoeukaryote would have had a single membrane, whereas modern mitochondria have a double (inner and outer) membrane. The double membrane is not optional, but critical for its function to charge ADP. The inner membrane contains numerous plate-like folds called *cristae* that possess membranous sacks containing enzymes. Cristae can be either exclusively lamellar or exclusively tubular, but some mitochondria contain both types. Another difference is that the mitochondrial inner membrane has a different chemical composition from that of prokaryotes but is the same as in eukaryotes—contrary to the endosymbiosis theory's prediction.

Margulis proposed "that eukaryotes formed as a result of a gradual multi-endosymbiotic union with prokaryotes. In contrast, others, like de Duve and Stanier, proposed that phagotrophy, which requires a dynamic cytoskeleton, an endomembrane system, and the loss of the prokaryotic rigid cell wall, evolved prior to endosymbiosis." In contrast to this proposal phylogenetics based on mtDNA later concluded mitochondria could have evolved only once from an α-proteobacterium.[20] The endosymbiosis view of organelle evolution is widely accepted not because of empirical evidence, but because no other theory is even remotely plausible.[21] For this reason, Battley describes endosymbiosis as "tentative at best".[22]

Because no physical evidence exists for most steps of the transition from prokaryote cell to eukaryote cell, armchair reasoning (i.e. mitochondria and chloroplasts have small plasmid DNA that superficially resembles prokaryotic DNA) is exploited as support. In fact, organellar DNA is *more similar* to eukaryotic nuclear genes. A well-known example of some organelle genes resembling eukaryotic nuclear genes is the presence of introns, which are rarely present in prokaryote genes.[23]

Endosymbiosis does not solve the organelle origins problem

Although the endosymbiotic origin of mitochondria and chloroplasts is now textbook orthodoxy,[24] proposals that most "other cellular compartments are the result of symbiosis. … are not so widely accepted".[25] For most other organelles, endosymbiosis is recognized by many researchers as an implausible explanation for their origin. (It is also an inadequate explanation for the mitochondrion and the chloroplast, though the chloroplast evolution theory will be addressed in a separate paper).

Endosymbiosis an inadequate explanation for mitochondria

A major scientific problem with the endosymbiosis hypothesis is that as soon as the theory first appeared it was (and still remains) untestable.[26] The problem is endosymbiosis "proposes no real mechanism and most textbooks show the simplistic picture of a cell that swallows another cell that becomes a mitochondrion."[27] Actually, it is now far less plausible than when first proposed because a great deal more is known today about organelles (e.g. mitochondria) and bacteria.

Among the other basic problems with the theory are: What prevented the host cell from digesting the invading organism? and: Where did the many other structures required for a eukaryotic cell to survive come from (figure 4)? For example, microtubules are not explained by the theory, even though they are needed for cell division and motility in eukaryotic cells. De Duve notes that nothing is known about the evolution of the cell cytoskeleton system, which requires many new innovations to function. Similar lines of evidence cited to support the theory that spirochete bacteria gave rise to flagella are problematic. Tubulin, the primary component of microtubules in eukaryotic cells, has not been found in any prokaryote. For these reasons, most evolutionary biologists reject the idea that flagella, tubulin and most other cellular structures originated by endosymbiosis. At best, endosymbiosis explains the origin of one or two organelles. But for

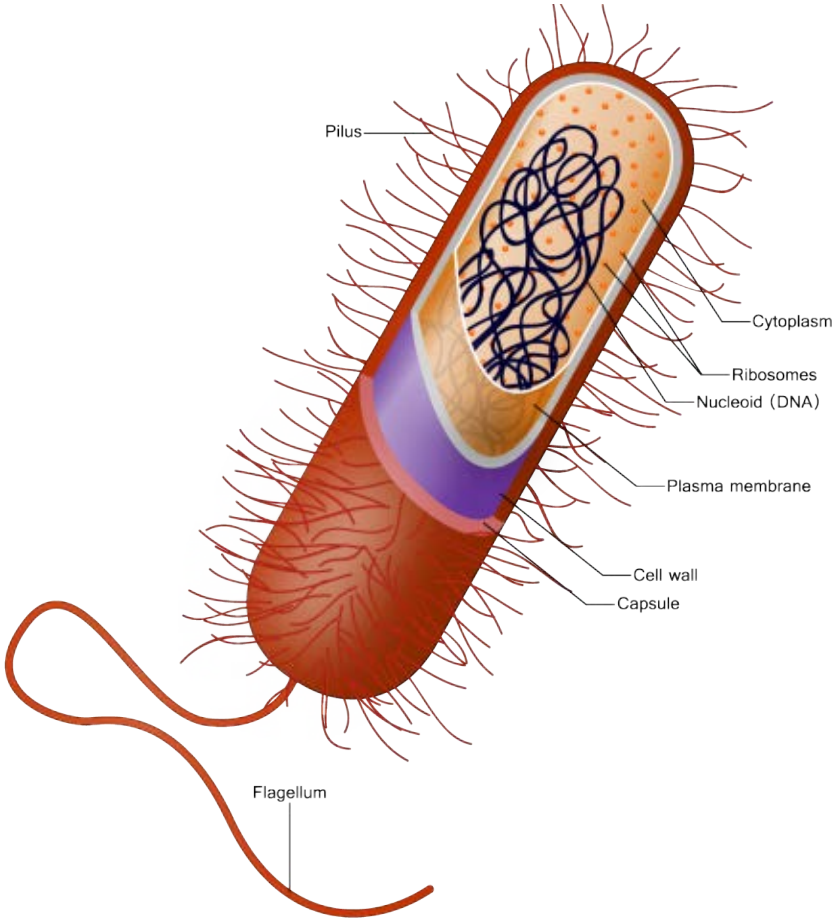

Figure 2. Simplified representation of a bacterial cell and its interior

a eukaryotic cell to function, a whole new set of structures is required, all of which must evolve concurrently for functional integrity.

Major ribosome differences and the mitoribosome

A major argument for the endosymbiotic theory of organelle origins was that the structure of mitochondrial ribosomes is "distinctly different" from that of eukaryotic ribosomes, and mitochondrial ribosomes resemble those of prokaryotes.[28] Contrary to the endosymbiotic theory, though, mammalian mitochondrial ribosomes, and the amino acid sequences that produce the ribosome, are completely different from the corresponding features in prokaryotes.[29] Mitochondrial ribosomes are in fact so different from bacterial ribosomes that they are designated as the *mitoribosome*.

When endosymbiosis was first proposed, it was assumed that ribosomes existed in only two forms, a smaller 70S variety used in prokaryotes, and a larger 80S ribosome used in eukaryotes. The S in 70S refers to the unit in which the sedimentation factor is expressed. The *sedimentation coefficient* measures basic morphological differences, a quantity related to the size of the particle which is equal to the terminal outward velocity of the particle when centrifuged in a standard fluid medium divided by the centrifugal force acting on it.[30] The ribosomes used in mammalian mitochondria were *expected* to resemble the prokaryotic 70S ribosome because they were similar in size. Instead, researchers found that "Mammalian mitochondrial ribosomes (55S) differ unexpectedly from bacterial (70S) and cytoplasmic ribosomes (80S), as well as other kinds of mitochondrial ribosomes."[31]

Mitochondria employ a system required to manufacture proteins that is also very different from bacteria. Mitochondrial ribosomes called mitoribosomes are described as 'undersized', mini-ribosomes having mini-RNA polymerase, and even mini-DNA.[32] Mitoribosomes differ from prokaryote ribosomes in RNA, protein content, and position/function of the ribosome parts, and are significantly different in DNA sequence (especially regions that do not contact the tRNA or growing polypeptide chain). Unique features of the mitochondrial ribosome include novel mRNAs that process mitochondrial mRNA and a novel guanosine triphosphate (GTP) binding site used during polypeptide elongation.

Other contrasts between bacterial ribosomes and mitoribosomes include many basic construction and assembly differences. Proteins comprise a larger portion of mitoribosomes than prokaryotic ribosomes. Some of these proteins are in novel positions and have functions different from the prokaryotic ribosome. One of many examples includes the 55S mitoribosome, which is held together by 15 intersubunit bridges and only six of these bridges are similar to those employed in prokaryotes.[33] Furthermore, 33 of the 81 proteins identified so far in human mitoribosomes have no homologues in prokaryotic ribosomes.[1,34]

These examples of the many differences between the prokaryotic and mitochondrial ribosome further illustrate the chasm between the two ribosomes. More examples could be documented and undoubtedly more will be discovered with further research.

The phagocytosis problem

Another issue is that phagocytosis supposedly brought a proteobacterium into prokaryotes by "phagocytosis" of

bacteria, but "The precise nature of the host cell that partnered with this endosymbiont is, however, very much an open question."[1] The problem is archaea—in fact all prokaryotes—"cannot perform phagocytosis, and there is not any reason to believe they ever had such abilities."[35] Consequently, "the means by which the endosymbiont entered its host is an enigma."[35] The reason why prokaryotes lack phagocytosis ability is because it is a complex process requiring

> "… a flexible cell wall, a dynamic internal cytoskeleton with motor proteins that interacts with a complex endomembrane system, lysosomes that bud from the Golgi complex and are targeted to food vacuoles, and particles enclosed in a phagocytotic cup that are based on the spatially controlled polymerization of actin. These characters are absent from prokaryotes."[36]

One theoretical solution to this problem suggests the invasive organism, "was a small (facultative) aerobic α-proteobacterium, which penetrated and replicated within the host periplasm, and later became the cell mitochondria."[37] This just-so story so far lacks empirical conformation.

Other ways mitochondria differ from bacteria

Mitochondria are important organelles because they contain the machinery and enzymes necessary to convert food into an energy-carrying molecule called *adenosine triphosphate* (ATP). The enzymatic process by which the mitochondria convert food to adenosine triphosphate (ATP) is called *oxidative phosphorylation*. The end process involves converting adenosine diphosphate (ADP) to the high-energy molecule ATP. Mitochondria produce 90% of the cell's energy, and their impairment causes several diseases that affect the central nervous system and, eventually, other systems.[38] The mitochondria produce this energy from fats, sugars, and protein; mitochondria are found in all human cells except enucleated red blood cells.

Called 'the powerhouses of the cell', we now know that the more-active cells, such as muscle, liver, and kidney tubule cells, contain large numbers of mitochondria. Conversely, the less-active cells, such as mucus-secreting cells, contain relatively few mitochondria. Other functions of the mitochondria are regulatory, including helping control the cytoplasmic calcium level.[39] They are also involved in specific kinds of lipid synthesis.[40]

The inner membranes contain a large set of enzymes that convert food to charge ADP by a series of reactions called the *Krebs cycle* or *citric acid cycle* that produces oxidative phosphorylation. The inner mitochondrial area, called the *matrix,* is filled with gel containing scores of different kinds of enzymes. The inner and outer membranes differ both in enzymatic activity and lipid composition. Some of the enzymes, such as ATPase, are permanently attached to the mitochondrial membrane.[41] In short, mitochondria are very different from bacteria.

Genes controlling mitochondria

As noted, the mitochondrion is a unique organelle because it contains its own DNA (mtDNA) in the form of plasmids. Mitochondrial DNA is used exclusively for the organelle's own functions, specifically to provide control, although not complete, over its own replication.

Human mtDNA has been completely sequenced. Its 16,569 base pairs code for 37 genes that include only 13 protein-coding genes, 22 tRNA genes, and two rRNA genes, all of which are essential.[42] Respiration systems cannot function unless all these proteins and tRNAs are present. These are only a *few* of the genes required by human mitochondria. Close to 90% of proteins imported from the cytoplasm are encoded in the nucleus, indicating a high level of integration that argues endosymbiosis is untenable.[43]

Because most genes controlling mitochondria are not located in the organelles themselves, but in the cell's nucleus,[44] a transfer of genes from the organelles to the host nucleus must be postulated by endosymbiosis supporters. This problem is not minor: "the migration of genes from endosymbionts to the nucleus is remarkable because it seems to have raised more difficulties than it solved."[45] Another problem is:

> "… in what form do the transferred genes physically make that intracellular journey—as RNA, as cDNA, as pieces of organelle DNA, or as whole organelle chromosomes? Current views focus upon cDNA as the vehicle, based upon some examples from plants. But other mechanisms, involving direct transfer of DNA from organelle chromosomes, could also account for the available data."[46]

The analogy is not unlike hypothesizing the moving of a small house into a larger house as a means of explaining the larger house's rooms when they can be explained more easily, even from an evolutionary standpoint, by hypothesizing their individual separate construction. This concern is significant in that the genes in mitochondria were a major original evidence for the endosymbiosis theory. From a Darwinist standpoint, the hypothesis which endosymbiosis replaced, the process of ingrowing membranes within the host cells forming all of the organelles, including the nucleus, appears more plausible and thus still has adherents. As the problems with endosymbiosis accumulate, the membrane-ingrowth hypothesis may again become popular.[47]

In short, genetics suggests this gene transfer *must* have occurred if endosymbiosis occurred. The real problems are: how pre-eukaryotic cells survived until the genes were transferred, how they survived before this transfer, and why and how they were transferred. Mitochondrial replication appears to require the nuclear control system because, as far as is known, it is universal. Nonetheless, why many genes important for mitochondrial function are located in the nucleus

and how they got there is the subject of much evolutionary speculation.[48]

One of the most unexpected discoveries has been the paucity of genes that would support endosymbiosis. One study found, in contrast to the theory's expectations, that comparisons with the organism, called the α-proteobacterial endosymbiont, widely believed to be the bacterial endosymbiont

> "… have identified a conserved core of proteins descended from the α-proteobacterial endosymbiont that gave rise to the mitochondrion and was the source of the mitochondrial genome in contemporary eukaryotes. A surprising result of phylogenetic analyses is the relatively small proportion (10–20%) of the mitochondrial proteome displaying a clear α-proteobacterial ancestry. A large fraction of mitochondrial proteins typically has detectable homologs [sequence similarity] only in other eukaryotes and is presumed to represent proteins that emerged specifically within eukaryotes."[49]

The authors concluded:

> "Understanding the origin and evolution of the mitochondrion remains a challenge, despite the flood of relevant biochemical, cell and molecular biological, and phylogenetic data and insights that have accumulated in the almost five decades since the modern resurrection of the long-standing endosymbiont hypothesis; the idea that this organelle is a tamed and highly reworked endosymbiotic bacterium. The abundance of information bearing on eukaryotic cell evolution (particularly and most recently sequence data) and differences over how the data are analyzed and interpreted have prompted a plethora of often-conflicting ideas about when and how, within an endosymbiotic context, the mitochondrion originated."[50]

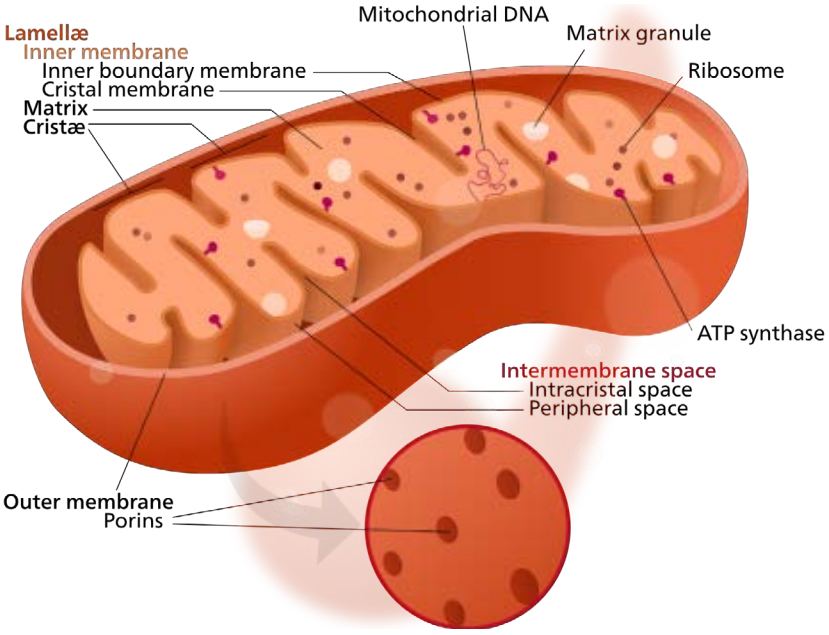

Image: Kelvinsong/CC BY-SA 3.0

Figure 3. Simplified diagram of a mitochondrion. Note the striking difference to the bacterial cell in figure 2.

Mitochondria dependent on the nuclear genome

Another major problem with endosymbiosis is that the mtDNA genome is not independent but is functionally integrated with the nuclear genome. Over 90 proteins are required to produce mitochondrial ribosomes, and nearly all of them are supplied to the organelle from the host nucleus. (Of the references checked, none could give a specific number which, as of this writing, is unknown.) These genes are encoded by nuclear DNA; the resultant proteins are synthesized in the cell cytosol, and then individually transported into the organelle.

Human mitochondria "must import 99 percent of their proteins from the cytoplasm."[51] It would be far simpler (and therefore per the 'law of parsimony' a better explanation) to evolve mitochondria from scratch than to incorporate an independent organism which required: 1) the loss of most of its genes; 2) the evolution of many new ones, which involves; 3) the fact that most of the genes required to function must have originally evolved in the nucleus and, without these genes, the mitochondrion could not function. Furthermore, use of the two-gene system, nuclear and mitochondrial, requires the evolution of extremely complex import machinery involving complex surface receptors, binding relays, and a target signalling system.[52]

Another difficult problem is that some mitochondria use genetic codons that are different from *all* bacterial and eukaryotic codes. For example, the codon CUA normally codes for leucine, but in yeast mitochondria codes for threonine. In fact, multiple codes exist to code for threonine, and there are expanded codon recognition patterns for other amino acids.[53] For these reasons, some theorize that the mitochondrial code has been evolving in certain yeast mitochondria, because, as far as is known, all yeast mitochondria have the same code differences compared to bacteria.[54] As more genetic sequencing is completed on different mitochondria of other organisms, other coding differences will likely be found.

A mitochondrial code that was the same as used in bacteria, but different from that used in eukaryotes, if that were the case, might argue for endosymbiosis. But the difference that actually exists has forced some evolutionists to hypothesize

that the mitochondrial code is more 'primitive' and the bacterial code more evolved. In contrast to this view, the difference is better explained by the view that the mitochondrial code is designed for the specific needs of mitochondria, specifically to *prevent* exchange of mtDNA genes with nuclear genes.

Moves the problem elsewhere

Another major problem with the endosymbiosis theory is that it does not solve the problem of organelle evolution. Instead, it avoids the problem because it *starts* with the existence of a complex, functioning system that it cannot explain. For purposes of argument,

> "… suppose that the symbiosis Margulis envisions was in fact a common occurrence throughout the history of life. The important question for us biochemists is, can symbiosis explain the origin of complex biochemical systems?
>
> "Clearly it cannot. The essence of symbiosis is the joining of two separate cells, or two separate systems, *both of which are already functioning*. In the mitochondrion scenario, one preexisting viable cell entered a symbiotic relationship with another such cell. Neither Margulis nor anyone else has offered a detailed explanation of how the preexisting cells originated."[55]

Furthermore, the proponents of the symbiotic theory must "assume that the invading cells could already produce energy from foodstuffs; they [also] explicitly assume that the host cell already was able to maintain a stable internal environment that would benefit the symbiont."[56]

Margulis and Sagan proposed that the earliest eukaryotic cells were the protoctists: the amoebas, diatoms, giant kelps, and red seaweeds.[57] These eukaryotic creatures, though, are in most ways more similar to the 'higher' level eukaryotes than to prokaryotes. Even though the endosymbiosis theory does not fit the facts reviewed in this paper, it, nonetheless, is periodically recycled when alternative theories are shown to be wrong.[2]

Another indication of problems in endosymbiosis is the widespread disagreement by researchers about mechanisms underpinning the concept. For example, Margulis and Sagan note that certain bacteria have been renamed 'archaea' by Carl Woese, a terminology now widely accepted.[56]

> "This classification rejects endosymbiosis and is a 'denial of their bacterial nature' because it results in elevating 'the group "archaea" to parallel status with other bacteria and all eukaryotes'. The result is three fundamental groups called domains, or superkingdoms, which contradicts the endosymbiont theory."[58]

Another concern is that endosymbiosis involves relatively rapid evolution that contradicts Darwinian gradual evolution. In view of the fact that no viable gradualist explanation for the evolution of eukaryotes exists, evolutionists were motivated to blend Darwinian gradualist and non-gradualist positions. O'Malley writes that, as Maynard Smith argued, endosymbiosis is explained by the standard mutations, and macromutations.[59] Other researchers argue that other factors must be accounted for, making eukaryote evolution even more complex (consequently making it less probable). For example, Edgar adds that "the concurrent evolution of the L-ascorbic acid redox system should be considered a key factor leading to evolution of multicellular eukaryotes and remains involved in the maintenance of multicellularity and many other eukaryotic characteristics."[60]

Why organelle evolution is impossible

Behe argues that the gap existing between eukaryotic and prokaryotic cells cannot ever be bridged because of irreducible complexity. The complexity of even a simple machine can be reduced only so far—below this, the machine cannot function. The classic example is a standard mouse trap, which must have a minimum of five main parts to operate: a platform, a holding bar, a hammer, a catch, and a spring.

A mouse trap will not function until *every* one of its necessary parts is in place, each of which must be designed properly to articulate with the other parts. One contrary suggestion is to propose that some of these parts can be eliminated by various methods, such as nailing the trap to the floor. This approach does not eliminate a part but replaces it with another part; the floor is used as the base. Likewise, organelles will not function unless *every* required, properly designed and manufactured part exists, and *all* of them must be properly assembled to form an operating system.[25]

Organelles are very complex structures, consisting of multi-thousands of smaller complex parts, and the irreducible complexity concern is *also* very likely true of each individual part in each organelle. A cell cannot survive without ribosomes, each of which contains thousands or even tens of thousands of molecules, each one of which must be assembled to exacting specifications.[61] Thus, cellular life is impossible until all of its necessary parts are manufactured and properly assembled. Even though DNA is described as representing "massive intelligence … [it] has by itself neither a future nor a present. DNA without a cell to sustain and express it has no physiologic meaning."[62]

Few scientists have even endeavoured to speculate on the details of the transitional forms between the hypothetical pre-organelles, let alone present evidence for the multi-thousands of transitional forms required to create a reasonable scenario that could bridge the free-living cells and the cells with organelles used in multicellular organisms.

The cell's transport system is another example that illustrates why the concept of irreducible complexity makes organelle evolution impossible. After proteins are manufactured, they do not float around freely inside the cell, but must be transported by an appropriate mechanism to wherever they

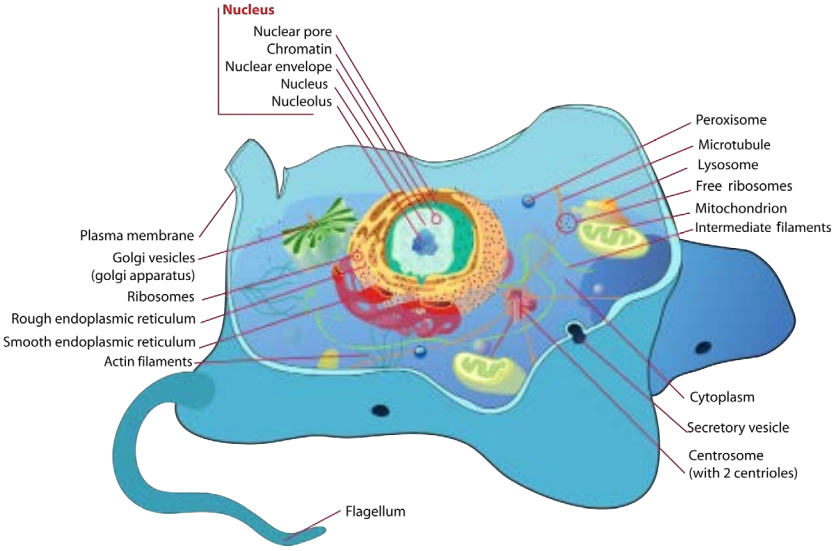

Figure 4. Endosymbiosis attempts to explain the evolutionary origin of only one organelle in animal cells. As of this date, the evolutionary origin of the 17 basic structures shown in the diagram above, including the mitochondrion, have no universally accepted explanation after 150 years of attempts. For most of the 17 structures, only tentative just-so stories exist. All of these structures are required in some form for a eukaryote cell to exist.

are needed. Two common mechanisms to transport proteins are *gated transport* and *vesicular transport*.

Gated transport requires construction of a door between the cytoplasm and the nuclear membrane and a chemical sensor (a protein that has the correct identification tag). When the protein package approaches the sensor, it opens the gate, allowing the protein to pass through. This control mechanism requires the protein to have the proper identification tag and a gate programmed to open in response. The gate itself also contains many parts, thus introducing another level of irreducible complexity. Each of these gated transport components is complex and consists of thousands of parts at the molecular level, *all* of which must exist for the gated transport system to function.

The vesicular transport system also uses a set of specially designed sensors. But instead of a gate, the proper identification tag causes the compartment membrane to bulge outward, pinching off and forming a vesicle that totally surrounds the protein. The transport vesicle then travels to a destination predetermined by its identification tag. If the vesicle tag and identification sensor match, another sensor recognizes the vesicle, and it merges with the compartment.

Then, the pinching-off process is reversed to allow the proteins to be carried inside the new compartment. The almost certainly irreducible complexity of the system must include two complex sensor systems, two identification tags as well as the vessel itself. At a level beyond this, each sensor identification tag and the carrier vessels are, at the molecular level, likewise constructed from thousands of parts, each of which is also likely an example of irreducible complexity. The vesicle must contain all of the structures that allow it to bud off from the original compartment and then to unite with another compartment.[25]

Other problems with endosymbiosis

The standard endosymbiosis theory has recently been under attack from several fronts, and some researchers are now arguing for a new theory to explain the evolution of organelles. Some of these scientists believe that a new theory "could solve some nagging problems with the prevailing theory" of endosymbiosis. The details of this new theory are still vague. They admit that, even if a new theory is elegantly argued though, there will likely be a lot of difficulties some new hypothesis doesn't account for. Evolutionists also conclude that we may have to admit that

> "… the mitochondrion was a lucky accident. First, the ancestral cell—probably an archaebacterium, recent genetic analyses suggest—acquired the ability to engulf and digest complex molecules. It began preying on its microbial companions. At some point, however, this predatory cell didn't fully digest its prey, and an even more successful cell resulted when an intended meal took up permanent residence and became the mitochondrion."[63]

Furthermore, scientists believed for decades that

> "… they had examples of the direct descendants of those primitive eukaryotes: certain protists that lack mitochondria. But recent analysis of the genes in those organisms suggests that they, too, once carried mitochondria but lost them later (*Science*, 12 September 1997, p. 1604). These findings hint that eukaryotes might somehow have acquired their mitochondria before they had evolved the ability to engulf and digest other cells."[63]

Another problem with endosymbiosis is the widespread disagreement by researchers about the mechanism. One summary concluded:

> "… that 'mitochondrion-early' models that postulate the acquisition of the protomitochondrion by an archaeal host, are more plausible than 'mitochondrion-late' models. However, since prokaryotes are unable to perform phagocytosis, such models failed to suggest a reasonable mechanism by which the endosymbiont got access into its host."[64]

One solution to all these problems is more time for it to evolve. As Professor Edgar explains, it took 0.5 billion years for prokaryotes (bacteria and archaea) to evolve "quite complex biochemistry and some eukaryote characteristics" but

> "… the transition from unicellular prokaryotes to multicellular, aerobic eukaryotes took a further 2.5 billion years to begin. The key factor or factors that eventually caused this long-delayed transition is a question that has been a focus of considerable research and a topic of discussion over many years."[60]

Conclusions

Two major groups of organisms exist: prokaryotes and eukaryotes. No intermediate organisms have ever been found between them, with part-developed organelles. With possible minor exceptions, what is found is either an absence of organelles, or fully functional and fully developed organelles.[65] "No missing links between eukaryotes and bacteria exist, either in the fossils or in life."[66] Furthermore, it is even difficult to postulate by compiling just-so stories how the links between prokaryotes and eukaryotes could exist.

Endosymbiosis postulates that mitochondria were once free-living bacteria, and that "early in evolution ancestral eukaryotic cells simply ate their future partners."[67] Both the gradual conversion and endosymbiosis theories require thousands of transitional forms, with each new one providing the cell with a competitive advantage over the unaltered cells.

The endosymbiosis idea is popular, not because of the empirical evidence, but because no other hypothesis is remotely plausible. The complete absence of fossil and other evidence is another problem. Thus, Professor Battley describes the endosymbiosis notion as "tentative at best".[22] A major problem with endosymbiosis is that it has always been untestable.[68] More research and knowledge has motivated one researcher who is at the forefront of this field to conclude in 1998 that the studies

> "… published over the past two or three years, much of them from genome-sequencing projects, have hinted that it is time for a new theory. In particular, it is turning out that eukaryotic nuclear genomes carry many genes of bacterial (sometimes α-proteobacterial) origin which have nothing to do with mitochondrial functions. Moreover, mitochondrion-free eukaryotes that we had come to think of as direct descendants of ancient proto-eukaryotes carry mitochondrial genes in their nuclear genomes."[69]

Endosymbiosis theory has come under attack from many other quarters, and no doubt these attacks will continue.[70] The former head of Clemson University's Genetic Lab called endosymbiosis a theory in crisis that, at best, explains very little of the evolution of eukaryotes from prokaryotes. The origin of the entire new cell system, the eukaryotes, remains to be explained. He concluded:

> "… [the] sequences of many eukaryotic genomes are now clearly showing that the gene repertoires needed for the mitochondria to function are *not* derived from bacteria but are remarkably unique to the type of creature in which they are found. While certain genetic similarities do exist, these correspondences are plausibly explained by the standard engineering concept of code re-use—common code to solve similar problems. The wealth of genomic data is now utterly destroying the idea of evolution on all fronts, even in the area of endosymbiosis, one of the secularists' favorite theories."[71]

There are major problems with endosymbiosis theory. Mitochondria differ from bacteria—genetically, structurally, functionally, and operationally. Furthermore, time has not been helpful in explaining these differences within the theory's parameters but has only increased the contrast between the two.

This review can only outline some of the major problems with the attempt to deal with the chasm between prokaryotes and eukaryotes via the endosymbiosis concept. To effectively critique this problematic idea would really require an entire paper for each of the problem areas concerned.

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Kant's religion of reason and the reinterpretation of Genesis 1–3

Martin Duboisée de Ricquebourg

Given Immanuel Kant's seminal role at the outset of the Enlightenment, it is important to notice how and when he interacted with Genesis 1–3. Although Kant is largely remembered today for his philosophy, he began his career as a theologian and a scientist. In fact, it was the interaction between his theology and his science that provided the necessary foundation for his critical philosophy. I propose that Kant's rejection and subsequent reinterpretation of Genesis 1–3 was the *sine qua non* of his contribution to the Enlightenment.

Immanuel Kant (1724–1804) is commonly regarded as one of the greatest philosophers of all time.[1] But his intellectual career began with theology. On the 22 April 1724, Kant was born in Königsberg to devout Pietistic parents who named him Emmanuel,[2] "God is with him". His mother's prayer for him was:

> "May God sustain him in accordance with His Covenant of Grace until his final rest, for the sake of Jesus Christ, Amen."[3]

Kant was enrolled in the Pietistic school *Collegium Fridericianum* from the age of eight where his educators endeavoured to instil a favourable disposition towards Christianity in the hearts of their pupils.[4] Here he received instruction in Greek, Hebrew, church history, Luther's catechisms, along with studies from the Old and New Testaments.[5] Kant's theological education was rigorous, requiring him to read the Pentateuch, historical books, and Psalms in Hebrew and the entire New Testament in Greek.[6] Nine years later, in 1740, Kant entered the University of Königsberg, where he was finally given the freedom to control the direction of his own education, which, in turn, gave him access to the writings of radical thinkers like Christian Gabriel Fischer (1686–1751) and more moderate rationalists like Gottfried Leibniz[7] (1646–1716) with his disciple, Christian Wolff[8] (1679–1754).[9] To what extent Kant's critical philosophy began to formulate during this period or why he began to drift away from his Pietistic upbringing is unknown. Kant left behind no journal and the three "most reliable" early biographies of Kant's life relate "almost nothing" about the first twenty years of Kant's life.[10] All we know is that Kant once described his early religious schooling as the "pedantic and gloomy discipline of fanatics".[11] Before his 21st birthday, both his father and mother had died, and within less than 10 years of each other.[12] That said, nothing substantial can be made of this fact, for or against his eventual apostasy. What remains incontrovertible, as will be seen in what follows, is that this did, in fact, happen.

The death of Kant's father led to a six-year period away from the university, from 1748 to 1754, where he worked as a private tutor to an affluent family.[13] But in 1754 he returned to work on his dissertation and began writing his first controversial book—a book that he knew "would appear dangerous to those of 'true faith'".[14]

Kant rejects Genesis

Kant's book was entitled *Universal Natural History and Theory of The Heavens, or An Essay on The Constitution and Mechanical Origin of The Whole Universe, Treated In Accordance With Newtonian Principles* (1755). Knowing that it would be theologically iconoclastic, he was only content to publish it when he felt that he was "secure in relation to the duties of religion".[15] This state of affairs was achieved by Frederick the Great (1712–1786)—a known atheist—taking to the throne,[16] to whom Kant dedicated the volume.[17] Here we find, at the brink of Kant's academic career, a book that attempts to replace Genesis 1–2 with an explicitly materialistic account of the origin of the universe:

> "*Give me matter and I will build a world out of it*, that is, give me matter and I will show you how a world is to come into being out of it [emphasis in original]."[18]

Choosing to follow Newton instead of Moses, Kant developed the first 'nebular hypothesis'[19] prototype to explain the origin of the universe "through mechanical laws alone".[20] In this book he speculates that the universe may have taken 'millions of years' to evolve from chaos; that the earth may have "existed for a thousand or more years before it was constituted so as to support people, animals, and plants"; and that the world continues to evolve because "Creation is never complete … it will never stop."[21] But his confidence

Figure 1. Gottlieb Doebler's painting of Immanuel Kant (1791)

in mechanical causes stumbles at the origin of life. Kant's reticence here speaks for itself:

> "Are we in a position to say: *Give me matter and I will show you how a caterpillar can be created?* Do we not get stuck at the first step due to ignorance about the true inner nature of the object and the complexity of the diversity contained in it? It should therefore not be thought strange if I dare to say that we will understand the formation of all the heavenly bodies, the cause of their motion, in short, the origin of the whole present constitution of the universe sooner than the creation of a single plant or caterpillar becomes clearly and completely known on mechanical grounds [emphasis in original]."[22]

It was a problem that Darwin would attempt to solve a hundred years later. Yet, without Genesis, not only was Kant unable to explain the origin of life, he could not understand what it meant to be human:

> "We are not even properly familiar with what a human being actually is, even though consciousness and our senses should inform us about it; how much less will we be able to imagine what he will become in the future!"[23]

This anthropological quandary led Kant to categorize humanity into four races.[24] Predictably, this resulted in racism. Kant ranks the native 'inhabitants of America' "far below even the Negro, who stands on the lowest of all the other steps that we have named as differences of the races."[25] Following Hume, he asserts that

> "… among the hundreds of thousands of blacks who are transported elsewhere from their countries … not a single one was ever found who presented anything great in art or science or any other praise-worthy quality, even though among the whites some continually rise aloft from the lowest rabble, and through superior gifts earn respect in the world. So fundamental is the difference between these two races of man, and it appears to be as great in regard to mental capacities as in color."[26]

Incredibly, Kant believed that melanin is strongly correlated with intellect. Concerning a 'Negro carpenter', he writes, "this fellow was quite black from head to foot, a clear proof that what he said was stupid."[27] But for his own ethnicity and nationality, Kant reserves the highest praise:

> "Humanity is at its greatest perfection in the race of the whites. The yellow Indians do have a meagre talent. The Negroes are far below them and at the lowest point are a part of the American peoples."[28]

He says that Germans, being the pinnacle of humanity, have "a fortunate combination of feeling, both in that of the sublime and in that of the beautiful", exhibiting "more moderation and understanding" than the English or the French.[29]

Without minimizing other influences, it was Kant's science that strategically shaped both his theology and philosophy. Over the course of 56 years, Kant published a total of 16 scientific treatises.[30]

Kant rejects Christianity

In 1781, Kant completed his magnum opus, *Critique of Pure Reason*. In it he laid out his critical philosophy in answer to three primary questions: "What can I know?", "What ought I to do?" and "What may I hope for?"[31] Here Kant attempts to justify the epistemological basis for autonomous reasoning by dividing all knowledge into two spheres: phenomena ("the world of senses") and noumena ("the world of understanding").[32] For Kant, noumena describe entities beyond the realm of human experience, whereas phenomena describe the world of things that can be observed directly. Feeling the force of Hume's skepticism,[33] Kant ingeniously proposes a Copernican revolution in philosophy.[34] Put simply, this transcendental approach makes "man, not nature, … the source of the synthetic *a priori* truths that constitute genuine knowledge".[35] In other words, as Frame puts it, "Our most basic knowledge comes about not by the world's impressing it on the mind, but by the mind's impressing it on the world."[36] Subjected to this framework, biblical revelation becomes extraneous. To make the point obvious, Kant addressed the subject directly just over a decade later.

In two books: *Religion Within The Limits of Reason Alone* (1794) and *The Conflict of The Faculties* (1798), Kant showed where theology belonged within his critical philosophy. Frame considers the former treatise to be the "first liberal systematic theology".[37] Kant argues that the interpretation of the Bible does not depend on the "meaning of the writer" or whether the text has any basis in real history.[38] In fact, Kant actively discourages deriving any historical truths from Scripture because they are not "essential to salvation".[39] He insists that all historical claims should be settled by the "philosophical faculty", not the "biblical theologian".[40] This is because he believes the clergy to be "incompetent (in scientific matters)" and therefore ill-equipped to investigate any historical or scientific claims of Scripture.[41]

Consequently, this makes the "literal interpretation" of any biblical text an abomination to Kant who reasons that it will "hinder the real end of religious teaching" because "even the authors of sacred Scripture, being human, could have made mistakes".[42] Applying this same logic to the gospels, Kant regards the divinity of Christ to be an unnecessary doctrine, and the historicity of miracles irrelevant.[43] For Kant, Scripture is only useful for confirming universally accepted moral principles, which he calls "the supreme principle of all scriptural exegesis".[44] But it is also Kant's opinion, in the opening paragraph of his preface, that morality has no need of God or religion.[45] Thus, if the Bible has only morality to offer, on Kant's terms, it is a completely useless book. Yet, this does not stop him from prescribing how Scripture should be expounded:

> "In explaining the Bible to the people the preacher must be guided, *not by what scholarship draws out of* Scripture by philological studies, which are often no more than misleading guesses, *but by what a moral cast of mind (according to the spirit of God) puts into it*, and by teachings that can never mislead and can never fail to produce beneficial results. In other words, he must treat the text only (or at least primarily) as an occasion for anything morally improving that can be made of it, *without venturing to search for what the sacred authors themselves might have meant by it* [emphases added]."[46]

This kind of hermeneutic, being quintessentially eisegetical, betrays where Kant places his trust: autonomous human reason. His reference to "the spirit of God" is disarmingly disingenuous. For Kant, it is the "religion of reason" alone that determines the universal truths that Scripture cannot contradict.[47] Denying the Bible's inspiration and inerrancy, Kant asserts that the only "infallible interpreter" is human reason.[48] From this standpoint, he argues that the "true church" is exclusively derived from the "pure faith of religion, based entirely on reason".[49] Essentially, in Kant's theology, "man replaces God".[50]

Kant rejects God

Kant's replacement of God, however, was preceded by his displacement of God. In a short book entitled *The only possible argument in support of a demonstration of the existence of God* (1763), Kant almost expunges God from the realm of rationality by arguing that classical proofs for his existence "prove nothing at all".[51] The only possible argument for God's existence is found, according to Kant, "in the fact that the denial of the divine existence is absolutely nothing … of which the cancellation eliminates all that can be thought."[52] This apologetic insight, as it stands, might suggest that Kant allowed one type of transcendental argument to establish God's existence. But as his later writings show, this was not the case at all. In *Critique of Pure Reason*, Kant revisits the question of God' existence, but this time grants no validity to any rational arguments for God.[53] For reasons such as these, Bernstein believes that Kant "did more than any other modern philosopher to support and legitimize those who seriously question faith in a transcendent God."[54]

Seven years later, in his *Critique of Practical Reason* (1788), Kant returned to the subject again.[55] Here, however, he endeavoured to present a pragmatic case for believing in God's existence. This is because "it is morally necessary to assume the existence of God."[56] Kant calls this postulate a "hypothesis" or "pure rational belief".[57] Thus morality compels him to believe that "there must exist a being who rules the world according to reason and moral laws",[58] and "a universal judgment of the world".[59] In his third and final critique, *Critique of Judgment* (1790), he even goes so far as to delineate a moral proof for the existence of God.[60] But Kant's theism amounts to little more than an expedient abstraction, postulated for pragmatic reasons. To quote him:

> "This proof … *does not imply that it is as necessary to assume the existence of God* as it is to recognize the validity of the moral law [emphasis added]."[61]
>
> "The actuality of a supreme morally legislative author is, therefore, sufficiently proved simply for the practical employment of our reason, *without determining anything theoretically in respect of its existence* [emphasis added]."[62]

In other words, Kant realizes that he needs God to have a basis for morality, but at the same time he refuses to accept these grounds as sufficient proof for His existence. To quote the German poet Heinrich Heine (1797–1856), Kant "has stormed heaven, he has disposed of the whole crew, the ruler of the world swims, unprovable, in his own blood", but then, "as with a magic wand, he again animates the corpse of deism which had been killed by theoretical reason."[63]

But the idea of God continued to trouble Kant. In the last 10 years of his life, he wrote hundreds of pages on this problem.

Figure 2. Kant's tombstone near the cathedral of Kaliningrad. The inscription is a direct quote from his *Critique of Practical Reason.* In English it reads: "Two things fill the mind with ever new and increasing admiration and reverence, the more often and more steadily one reflects on them: *the starry heavens above me and the moral law within me.*"

Kant creates god

The unpublished project, later published as Kant's *Opus Postumum*, was considered by him to be his "chief work, a *chef d'oeuvre*", a "keystone of his entire system … to demonstrate conclusively the tenability and real application of his philosophy", "his most important work".[64] Here we have Kant's final thoughts on "the problem of transcendental philosophy" which "still remains unresolved: Is there a God?"[65]

As before, Kant realizes that he needs God to make morality meaningful. But he will not allow God to be God. Instead, God is redefined as a "thought-object", a "rational concept", a "legislative force", a "hypothetical being", but without personality or any existence outside of Kant's mind.[66] God becomes a figment of Kant's rationality, a necessary construct to underpin his moral framework, "a principle of the categorical imperative".[67] Kant quotes Spinoza, "we make God for ourselves". Even more provocatively, after describing God as an object created by the mind, he quotes from Genesis 1:26:

> "Transcendental philosophy is the self-creation (autocracy) of ideas, into a complete system of the objects of pure reason. In the Bible it says: Let us make man, and, behold, every thing was very good."[68]

In Kant's Genesis, therefore, "it is the human mind that creates the world out of nothing."[69] If there exists any real God in Kant's system, it is Kant himself.

In 1784, Kant wrote *An answer to the question: what is enlightenment?* In this short essay, Kant defines the "motto of enlightenment" as the "courage to make use of your understanding" or "freedom to make public use of one's reason in all matters".[70] It is important to notice that the freedom conceived of here is a freedom from the tyranny of any religious authority which he views as "being the most harmful" and "also the most disgraceful of all".[71] This is where we find the real heart of Kant's Enlightenment: the desire to be free from God,[72] or, as we have already seen, the desire to be God.

If this assessment is justified, Kant's legacy is inextricably connected to how he dealt with Genesis 1–3. It is of great interest to note, therefore, that just five years after finishing the *Critique of Pure Reason*, Kant returned to Genesis.

Kant reinterprets Genesis

In 1786, he wrote an essay entitled *Conjectures on the beginning of human history*. This time, instead of ignoring the first three chapters of the Bible, he sought to reinterpret Moses to suit his critical philosophy. The fact that he felt the need to do so is interesting in itself. At minimum, it shows that, for Kant, Genesis was a book too important to be ignored.

His main interest regarded the Fall of man. Instead of viewing Adam and Eve's sin as man's first step into slavery, Kant reenvisages it as man's first step into freedom:

> "He discovered in himself an ability to choose his own way of life without being tied to any single one like the other animals … . He stood, as it were, on the edge of an abyss. For whereas instinct had hitherto directed him towards individual objects of his desire, an infinite range of objects now opened up, and he did not yet know how to choose between them. Yet now that he had tasted this state of freedom, it was impossible for him to return to a state of servitude under the rule of instinct."[73]

To complete the picture, Kant equates God with "guardianship of nature", the command of God with man's instinct or "voice of nature", the sinless state of Adam as "purely animal existence", the temptation to sin as the "guidance of human reason", and the sin itself as man's liberation from being like the animals to becoming truly human.[74] Kant believes, therefore, that the fall of man was a necessary step in man's

"progress towards perfection".[75] Thus Kant turns Genesis 1–3 into a manifesto for the Enlightenment.

Given his radical reimagining of the Fall, it should not be surprising to find that Kant reinterprets the days of creation to suit his own ends. His claims that Adam and Eve had already existed for a "considerable interval of time" before we encounter them in the garden.[76] This is because, in Kant's mind, it would not be possible for them to walk, talk, and think without having acquired these skills progressively like a child. We know that he does not trust the chronology found in Genesis because in the aforementioned *The Conflict of the Faculties* he calls the "epochs of sacred chronology" 'questionable'.[77] But his real rationale for an older Earth can be found in his treatment on *Physical Geography* (1802). Here, Kant once again offers a hermeneutic for dealing with Genesis. This comes in the midst of a discussion on the implications of lava layers in the Italian province of Catania, which, according to contemporary geologists, required at least 16,000 years to form. The following advice is offered to Christians before they read Genesis:

> "Moses gives [us] the age of mankind but not the age of the earth. The earth may have been formed some thousands of years earlier, for we should not allow ourselves to be prevented by Moses's statements from giving consideration to physical evidence. For God, a period like a day is too long for creation; and for the formation of the earth it is too little."[78]

This kind of sophistry is merely patronizing because, for Kant, the Bible has no real epistemic value.

Conclusion

Kant was both a product and proponent of the Enlightenment. Despite his pietistic roots and subsequent theological training, Kant became convinced that man "must reason autonomously and must never reason in any other way".[79] One of the first steps taken in this direction was his rejection of Genesis. In fact, Kant's attitude towards the whole Bible is represented by how he treated its first three chapters. Put another way, Kant's rejection and subsequent reinterpretation of Genesis 1–3 was foundational to his religion of reason.

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3. Kuehn, ref. 2, p. 28.
4. Kuehn, ref. 2, p. 46.
5. Kuehn, ref. 2, p. 47.
6. Kuehn, ref. 2, p. 48.
7. Leibniz has been regarded as the "pre-eminent architect of the mainstream, moderate Enlightenment in Germany". He was responsible for bringing Baruch Spinoza's *Tractatus theologico-politicus* into France in 1672. He also adopted a rationalistic approach to miracles. Although Leibniz accepts most of Genesis as history, he still argues, for geological reasons, that the world is older than suggested by the text (Israel, J.I., *Radical Enlightenment: Philosophy and The Making of Modernity 1650–1750*, Oxford University Press, New York, p. 502, 2001. Lambe, P.J., Biblical criticism and censorship in ancien régime France: the case of Richard Simon, *The Harvard Theological Review* **78**(1/2):149–177, 1985; pp. 155–156. Cook, D.J., Leibniz on Creation: a contribution to his philosophical theology, in: Dascal, M. (Ed.), *Leibniz: What kind of rationalist?*: Logic, epistemology, and the unity of science, Springer, New York, p. 454, 2008. Leibniz, G.W., *Leibniz to Abbé Claude Nicaise*, Die philophischen Schriften von Gottfried Wilheim Leibniz (Ed.), Gerhardt, C.I., vol. 2, Weidmann, Berlin, p. 590, 2008. Strickland, L., Taking Scripture seriously: Leibniz and the Jehoshaphat problem, *The Heythrop J.* **52**(1):40–51, 2011; pp. 40, 47.
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10. Kuehn, ref. 2, pp. 13, 20.
11. Cassirer, E., *Kant's Life and Thought*, Yale University Press, New Haven and London, p. 16, 1981.
12. Cassirer, ref. 11, pp. 16–17.
13. Kuehn, ref. 2, pp. 95–96.
14. Kuehn, ref. 2, pp. 98–99.
15. Kant, I., Universal natural history and theory of the heavens or essay on the constitution and the mechanical origin of the whole universe according to Newtonian principles; in: Watkins, E. (Ed.), *Natural science*, Cambridge University Press, Cambridge, p. 194, 2012.
16. Prior to 1740, under the reign of the previous monarch, Frederick William I (1688–1740), the Pietists enjoyed a period of intolerance towards any dissenters. As Kuehn relates, this meant that "No theology student who cared about his future could afford to disagree openly with the Pietist professors or to be friendly with those who were not Pietists" (Kuehn, ref. 2, p. 69).
17. Kuehn, ref. 2, p. 82.
18. Kant, ref. 15, p. 200. Here Kant retains God as a first cause while trying to explain how matter could arrange itself into the present universe over time.
19. Even though the Nebular Hypothesis is often attributed to Laplace, "he only restated and developed it" (Pearson, K., Laplace, *Biometrika* **21**(1/4):202–216, 1929; p. 205.
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27. Kant, ref. 24, p. 57.
28. Kant, ref. 24, p. 63.
29. Kant, ref. 24, pp. 53–54.
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31. Kuehn, ref. 2, p. 241. Kant, ref. 25, p. 635.
32. Kant, ref. 25, p. 272.
33. In *Prolegomena to any future metaphysics that will be able to come forward as science* (1783), Kant famously relates how Hume had stimulated the development of his critical philosophy: "I freely admit that the remembrance of David Hume was the very thing that many years ago first interrupted my dogmatic slumber and gave a completely different direction to my researches in the field of speculative philosophy" (Kant, I., Prolegomena to any future metaphysics that will be able to come forward as science; in: Allison, H. and Heath, P. (Eds.), *Theoretical Philosophy After 1781*, Cambridge University Press, Cambridge, p. 57, 2002).
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40. Kant, ref. 39, p. 252.
41. Kant, ref. 39, p. 284. (NB: The parentheses are in the original)
42. Kant, ref. 39, p. 286.
43. Kant, ref. 38, pp. 81–83, 98–99.
44. Kant, ref. 38, pp. 119–120.
45. Kant, ref. 38, p. 33.
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Finding confident faith in the Bible: a response to Dr Joshua Swamidass

Paul Price and Jonathan Sarfati

Today, more than perhaps ever before in recorded history, 'science' and 'faith' are viewed as incompatible, and indeed competing, ideas. The former is viewed as an objective set of facts, while the latter is viewed as a set of feelings and emotions which are imparted to us by means of stories. All too often, faith is viewed as a more or less 'blind leap', or at the least, an 'emotional leap', while the intellect, on the other hand, is often considered to be irrelevant or even 'idolatrous'. Dr Joshua Swamidass, author of the theistic evolutionary essay "Finding Confident Faith in Science", has argued that Christians who employ the use of scientific arguments for God and/or the Bible are committing a kind of idolatry, and has stated that his faith comes from Jesus alone. But Swamidass' view of theology and science is lacking as a proper scriptural approach to either field.

Much like Dr Swamidass (figure 1), I (PP) encountered a severe challenge to my faith in childhood by way of evolutionism.[1] It is our eventual responses to this challenge, however, that are widely divergent. Unable to convince biblioskeptics using scientific arguments, Swamidass has concluded that such arguments are either weak or completely invalid. In fact, he does not believe science brings us to God at all. Instead, he argues for the use of a more personal appeal, based upon the inward experience of Jesus, and upon the historical evidence afforded to us by the fulfilled prophecies and the Resurrection (both of which, by the way, we fully endorse as powerful evidences). In this way, he has capitulated wholesale to the attacks on the historical Christian faith coming from the world of secular 'science', effectively ceding the main battlefield. He has retreated to a realm—history—which is perceived as being less involved with the sciences.

Prominent 20th century evolutionist Dr Stephen Jay Gould (figure 2) popularized the idea of NOMA (non-overlapping magisteria), which Gould himself derived from a papal letter by Pope Pius XII from 1950.[2] He maintained that the 'magisteria' or realms of science and religion were separate and non-overlapping. Religion had a say in faith and morals, while science had a say in empirical matters; but religion has nothing to say about science and vice versa. I (JS) pointed out the fallacies of NOMA many years ago.[3]

In a strange twist (considering his predilections in favour of secular science), Swamidass rejects Gould's 'non-overlapping magisteria', as well as all other efforts to suggest that the Christian faith need not interact with the physical realm:

> "The problem is that our faith makes unavoidable and important factual claims about what has happened in the physical world. We find that God reveals himself in history. According to Scripture, Jesus died and was buried. Three days later he rose again, and was seen by many. The Gospel is rooted here, in the Resurrection, a physical event in the material world that science does not and cannot affirm. We cannot, therefore, accept that science is the final authority of all things in the physical world. While we affirm the importance of science, we cannot accept it as a final authority."[4]

If you were not aware of the source of this quote, it would not be out of place in any modern biblical creationist publication! Indeed, by merely substituting the section starting with "Jesus died" with "God flooded the whole world" or "God created out of nothing in six normal days," we would have a wonderful paragraph explaining the main reason why a person must accept biblical creation over the modern evolutionary consensus. God has revealed not only Himself, in the person of Jesus Christ, but also a basic outline of the history of our planet, including its key and formative events.

Limits of science

'Science' is nothing but the systematized study of God's creation, the natural world. As humans, however, we are locked in one place in time: the present. We have no ability to travel through time, and our observations are limited therefore to the present, and to the records we possess of observations from the past. Scientists are able to inductively arrive at the principles governing the *ongoing processes of nature* by means of the scientific method, as first codified by Lord Francis Bacon (whom we will discuss a bit more later on in this essay) (figure 3). By conducting experiments that can be repeated, we can learn what works, and how it works. We can learn (some of) the basic principles of how nature operates.

But what of single past events? Using science, we can learn that, for example, balls drop at a certain acceleration *today*. Can we know whether a particular ball has been

Figure 1. Dr Joshua Swamidass

dropped in the past? Can we know that all physical laws have always operated in a constant manner? Answering these questions is much more difficult and involves a different method called *historical science*.[8]

Since the past cannot be repeated, we cannot produce repeatable experiments to determine what happened. Instead, we must rely on 1) eyewitness testimony and 2) forensic evidence. I (PP) have elsewhere argued that untainted eyewitness testimony should take precedence over forensics whenever possible.[9] In the evolutionary scheme, however, there is no eyewitness account which can verify the story of evolution. Instead, they build their case using forensic clues only. But can forensic clues, in principle, ever arrive at a greater degree of certainty than God's revelation in Scripture? The further back in time you try to build your argument from physical clues, the less clear and certain your claims about what has happened will be, by necessity.[10] Secular evolutionary science starts with the *a priori* assumptions of naturalism (no supernatural intervention) and uniformitarianism (the present is the key to the past) already baked in! Biblical science starts with "In the beginning, God created …".

Dr Swamidass doesn't engage with any of this, however, and instead uses the word 'science' throughout his essay in a monolithic, drastically oversimplified manner. He takes it for granted that evolution is 'science', in an unqualified sense, and that is the chief cause of his grave misunderstandings.

An artificial view of 'science'

As we have seen, Swamidass has an ill-defined view of science that fails to account for the dichotomy between empirical (operational) science and forensic (historical) science. This is, unfortunately, not the only problem. He also employs an artificially narrow view of what constitutes science in general, and whether the idea of doing science could be implied in Scripture. Concerning the question of whether one can find any evidence for God through science, he doesn't take a clear stance:

> "Is there a clear, strong, and convincing evidence or argument *in science* that will convince skeptics that God exists? Maybe, but the Bible itself does not tell us that this evidence exists [italics in original]."[11]

Note the two obvious problems with this statement: first, Swamidass confuses the issue of evidence for God by concerning himself with whether 'skeptics' (in general) become convinced by it. The Bible teaches that individuals who reject God are 'fools' (Psalm 14:1) who "by their unrighteousness suppress the truth" (Romans 1:18). Therefore, their unwillingness to be convinced is not, as Swamidass implies, an indicator of a lack of quality evidence. Rather, it is a result of their own unrighteousness in refusing to admit what the evidence indicates!

Second, Swamidass denies we should be able to find such evidence at all, even though it is clearly indicated in Scripture. Paul drives this point home in Romans 1:20:

> "For his invisible attributes, namely, his eternal power and divine nature, have been clearly perceived, ever since the creation of the world, in the things that have been made. So they are without excuse."

Swamidass must find a way to explain away this verse. He attempts it in the following manner:

> "Let us remember that this same passage teaches that human wickedness successfully 'suppresses the truth' that God reveals to us through nature. However, the Gospel of Jesus cannot be overcome by darkness (Jn. 1:5). Unlike nature, no human conspiracy can stand against the Gospel, and it is through Jesus that we tum from idolatry to see him correctly in our world."[12]

This is perhaps the strangest statement in the entirety of the essay. What possible 'human conspiracy' could act to hide the evidence for God that exists all throughout nature? We leave it to the readers to ponder what sort of conspiracy Dr Swamidass could be referring to here. What Paul was really talking about by suppressing the truth we have already discussed: scoffers and skeptics suppress the power of the evidence in their own hearts, because they do not want to be convinced by it.

"Let us also remember that modern science did

> not exist when Paul wrote: 'since the creation of the world, God's invisible qualities have been clearly seen.' Science as we know it did not arise for at least another 1500 years. Paul was writing something that made sense within the context of his own time, when belief in God or gods was pervasive. … No, Paul is not speaking of scientific arguments. Rather, he writes of the awe and wonder we all experience in nature's beauty, mystery, power, and vastness, and how this declares an encounter with something transcendent: the grand, the invisible, and the eternal."[12]

Here is a bait-and-switch manoeuver. It's true that *modern* science (i.e. the Baconian scientific method) did not exist in Paul's day. But modern science is just an extension of science in general, which is nothing more than the study of nature, which God made. Were people in Paul's day not able to observe or study nature? The basic intuition of design is a very scientific one. The author of Hebrews states, "For every house is built by someone, but the builder of all things is God" (Hebrews 3:4). This statement is an inductive, scientific one, long before the 'modern' scientific method.

Swamidass claims that Paul's statements were made in the context of a time when belief in gods was (allegedly) pervasive. But let us remember that Paul's subject in this passage is specifically people who *deny God.* There is more than one way to deny God! Some deny that any gods exist at all. But others ignore the evidence from nature that we have *one infinite Creator,* and substitute in His place a multiplicity of finite gods (idolatry). According to Paul, both groups are suppressing the evidence from nature. Missing this point entirely, Swamidass goes on:

> "Even recognizing God in nature, we all still turn to idols. Our world sees the beauty and power that science uncovers in nature, declaring an immortal Glory. Nothing in science dampens this declaration. Now, in response, our world trusts instead in human science. We exchange the immortal God—who put nature's laws into place-for a science idol."[12]

'Human science' is nothing more than humans examining God's creation. That is not an idol. The idols that Paul spoke of were carved of stone and wood. Swamidass turns biblical truth on its head and pronounces it 'idolatry' to recognize the evidence for God that exists in God's creation. He reduces God's revelation in nature to a mere feeling of awe, rather than overwhelming evidence that renders a person a 'fool' who rejects God. A fool is not someone who rejects an *emotional experience*. A fool is someone who rejects sound doctrine and sound logic. Indeed, most atheists will admit to experiencing feelings of awe and beauty when they look at nature—they simply refuse to admit the Source. An example of this can be found in the following quote by atheist Carl Sagan:

> "We all have a thirst for wonder. It's a deeply human quality. Science and religion are both bound up with it. What I'm saying is, you don't have to make stories up, you don't have to exaggerate. There's wonder and awe enough in the real world. Nature's a lot better at inventing wonders than we are."[13]

As we can see, atheists have no problem experiencing these feelings that Swamidass claims they must be suppressing. Feelings are not the subject of Paul's treatise in Romans 1. Paul is speaking to us of the overwhelming evidence for God from "what has been made".

Without excuse?

In Romans 1, Paul said that even those who do not know Christ have no excuse, because God's power can be seen in creation. However, according to Stephen Jay Gould, one of Darwin's main motivations was to counteract the argument from design.[14] So if evolution were true, where is the clear evidence for God's power from what has been made? Far from being evidence for a divine hand, evolution, according to Gould, gives evidence that "there's nothing else going on out there—just organisms struggling to pass their genes on to the next generation. That's it."[15] In an earlier essay, Gould affirmed:

> "Our failure to discern a universal good does not record any lack of insight or ingenuity, but merely demonstrates that nature contains no moral messages framed in human terms. Morality is a subject for philosophers, theologians, students of the humanities, indeed for all thinking people. The answers will not be read passively from nature; they do not, and cannot, arise from the data of science. The factual state of the world does not teach us how we, with our powers for good and evil, should alter or preserve it in the most ethical manner."[16]

So once again, *if evolution were true*, as Dr Swamidass claims, there is no evidence for a God from what has been made, but evidence only for ruthless struggle for existence. Why would unbelievers be 'without excuse' if evolution were true?

Similarly, when Paul taught the Athenians on Mars Hill, he taught them about the Creator God:

> "The God who made the world and everything in it, being Lord of heaven and earth … And he made from one man every nation of mankind to live on all the face of the earth, having determined allotted periods and the boundaries of their dwelling place, … The times of ignorance God overlooked, but now he commands all people everywhere to repent, because he has fixed a day on which he will judge the world in righteousness by a man whom he has appointed; and of this he has given assurance to all by raising him from the dead." (Acts 17:24–31)

Paul once again told his hearers that they were ignorant of the Creator but should not have been. Up till then, God had been merciful to the ignorant, but no longer. Now

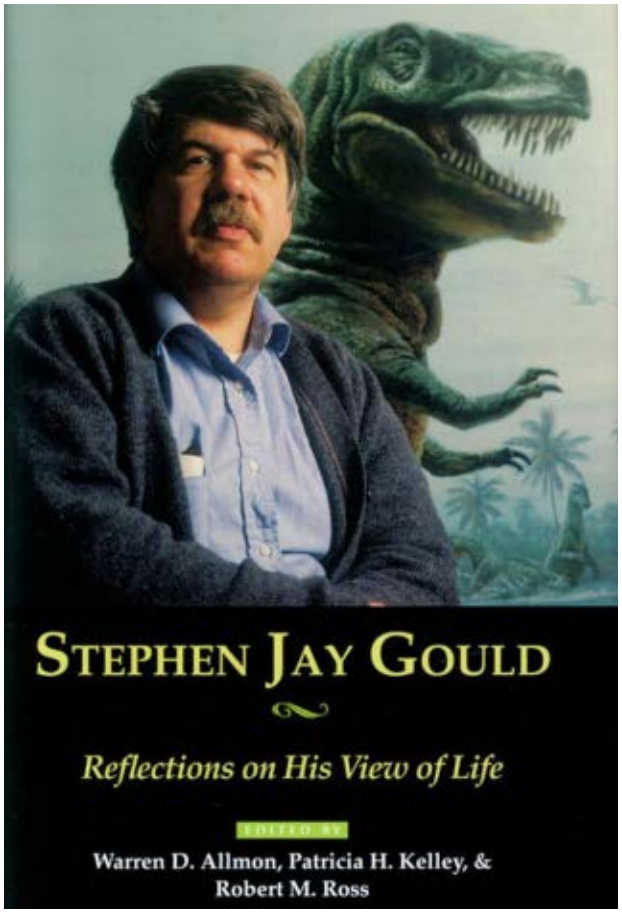

Figure 2. Stephen Jay Gould (1941–2002), who popularized 'NOMA', the idea that science and religion were Non-Overlapping MAgisteria.

He commands repentance, and He provided extra proof by raising a man from the dead. Note that Paul's preaching of Christ is not in a vacuum, but in the framework of creation. From now on, people would not be excused for ignorance of the Creator.

Swamidass quote-mines Francis Bacon

Not content with abusing Paul's words, Swamidass felt the need to twist Francis Bacon's words as well:

> "In 1660, at the dawn of modern science, Francis Bacon wrote of misguided attempts to understand God from nature: 'this unwholesome mixture of things human and divine there arises not only a fantastic philosophy but also an heretical religion.'"[17]

Taking Bacon's words in context leads to a very different conclusion than the one Swamidass is asking us to draw. In speaking of an 'unwholesome mixture', Bacon was referring to secular human philosophy (e.g. of the Aristotelian and Platonic varieties), *not* science. And of course, Bacon could not have been more correct on this point. This is, in fact, exactly what Swamidass himself is guilty of, in attempting to mix Christianity with evolutionism. As Bacon said, this has produced a fantastic philosophy as well as heretical religion (e.g. evolutionary syncretism[18]). In the same work (not far from the place Swamidass quoted), Bacon wrote:

> "… there are [some people] who appear anxious lest there should be something discovered in the investigation of nature to overthrow, or at least shake, religion, particularly among the unlearned … . But any one who properly considers the subject will find natural philosophy to be, after the Word of God, the surest remedy against superstition, and the most approved support of faith. She is, therefore, rightly bestowed upon religion as a most faithful attendant, for the one exhibits the will and the other the power of God. Nor was he wrong who observed, 'Ye err, not knowing the Scriptures and the power of God', thus uniting in one bond the revelation of his will and the contemplation of his power."[19]

The above passage demonstrates that Bacon was arguing the exact opposite of Swamidass' view. He believed that science was a remedy against superstition and a support of the Christian faith—*not* that such was idolatry.

2 Peter 3—a key passage undermining Swamidass' view

A related argument concerns another important part of biblical history, revealed in three chapters of Genesis. This is the Flood of Noah's day. The Apostle Peter treats this as a historical fact with a warning for today. 2 Peter 3:3–7 is an important passage:

> "… scoffers will come in the last days with scoffing, following their own sinful desires. They will say, 'Where is the promise of his coming? For ever since the fathers fell asleep, all things are continuing as they were from the beginning of creation.' For they deliberately overlook this fact, that the heavens existed long ago, and the earth was formed out of water and through water by the word of God, and that by means of these the world that then existed was deluged with water and perished. But by the same word the heavens and earth that now exist are stored up for fire, being kept until the day of judgment and destruction of the ungodly."

This strongly implies that the Flood must have left some dramatic evidence. Otherwise why would scoffers be held culpable for deliberately ignoring the facts of Creation and Flood if there is no evidence? The biblical Flood is not compatible with Dr Swamidass' belief in billions of years. The Flood would have produced the fossiliferous rock layers quickly, not over vast eons of time. Indeed, the whole idea of vast eons was produced by Enlightenment figures trying to undermine the Bible as a historical book.[20]

We must go further, because Swamidass responds in this way:

> "The key point is that Peter is warning of scoffers that don't believe that God will judge sinners for their sins. He says that they deliberately forget that God has judged people in the past (in the flood). With that context in mind, a regional flood to destroy AE's descendants does not diminish the point in any way. The flood is in fact a real event to which Scripture testifies, demonstrating the God of the Bible does judge sinners for their sins. One would have to willfully ignore this part of Scripture's testimony to argue that God would never harshly judge sinners for their sins."[21]

Or in other words, he is claiming this passage is only talking about the scriptural record of the Flood, and not any outside scientific evidence for it.

The first point to be made here is that Peter's wording in the above passage rules out any 'local' or 'regional' Flood scenario by his use of the Greek word *kosmos,* which carries a universal meaning (harkening back to the clearly universal language used in Genesis). For example, Bible translator Dr Robert Bratcher directly addressed the meaning of *kosmos* in that passage:

> "Often *kosmos* refers to this world in which we live, the earth. … 2 Pet 2.5 speaks of 'the ancient world' that was destroyed by the Flood, a world filled with godless people; the same context appears in 2 Pet 3.6, which speaks of "the world that existed then" that was destroyed by the Flood."[22]

A second important point is that old-earthers, like Swamidass, fail to bring the Bible into conformity with secular 'science' even *with* their local flood scenarios. That's because, without the *global* evidence for a *global* Flood, there is no universally accepted geological evidence for a large, localized flood in the area of ancient Mesopotamia. Ironically, they refuse to accept the huge quantities of evidence we do possess for a global Flood, and instead retreat to a position for which there really is no good evidence. At least one adherent to this idea with whom I (PP) have conversed has responded to this problem by suggesting that we have no idea where on the globe the Flood of Noah may have actually occurred. That is demonstrably false, since the Bible gives us a post-Flood geographical anchor point in the 'mountains of Ararat'.[23] For this reason, it is a major problem that no local flood in this region could possibly satisfy the biblical description. Wouldn't the Ark have been washed away from mountains and into a flatland area, perhaps even off the continent, given the time afloat?

Perhaps the most important reason that 2 Peter 3 indicates extra-biblical evidence is being ignored by the 'scoffers' is that Peter singled out the *cause* of their denial: the philosophical rejection of miracles and unique catastrophic events in history (i.e. uniformitarianism): "all things are continuing as they were from the beginning of creation." This brings into focus the reason why Peter thought to bring up both creation and the Flood as objects of their ridicule. It is precisely these two events in world history that chiefly violate the skeptics' principle of uniformitarianism. Both were unique, non-repeatable events for which there are no modern-day equivalents, and both had major impacts upon the evidence we possess in geology today. For those like Swamidass who want to deny that the Bible's history can be open to scientific investigation, it becomes impossible to explain the connection between these three concepts (uniformitarianism, Creation, and the Flood) in Peter's writing.

'What about those who have never heard?'

This is a commonly raised question.[24] A good answer is vital for the doctrine of missiology (missionary work to unbelievers). Peter and Paul inform us that everyone lacks excuse for unbelief in both Creation and the Flood because the revelation is clear. Thus, everyone stands condemned, even if they haven't heard of Jesus. Therefore, Paul stresses the urgency of telling everyone about Christ and what He has done to take away our sins:

> "How then will they call on him in whom they have not believed? And how are they to believe in him of whom they have never heard? And how are they to hear without someone preaching? And how are they to preach unless they are sent? As it is written, 'How beautiful are the feet of those who preach the good news!' But they have not all obeyed the gospel. For Isaiah says, 'Lord, who has believed what he has heard from us?' So faith comes from hearing, and hearing through the word of Christ" (Romans 10:14–17).

However, Dr Swamidass' approach minimizes the culpability of unbelievers before they have heard of Christ, in contrast to the Scriptures.

Science above Scripture?

We support many of Dr Swamidass' points about not elevating science to the same level as divine revelation. However, we wish he would be more consistent. He doesn't believe that Genesis is a literal historical record of creation in six normal-length days, separate creation of different kinds of creatures, or a global Flood that wiped out every human and land vertebrate not on the Ark (to list some major examples). The reasons presented by modern-day revisionists like Dr Swamidass are that they allegedly are correcting centuries-old mistakes in biblical interpretation (a kind of chronological snobbery). But if you look at the historical development of these compromise views, they clearly arose as a result of a desire to fit secular scientific ideas like deep

Figure 3. Francis Bacon, 1st Viscount St Alban, pioneer of the scientific inductive method

time and evolution with the Bible.[25] Science, however, is limited and fallible, so should not be used to overrule God's infallible written Word.

Jesus and Genesis

Swamidass commendably wants to get people back to Christ, but he doesn't go nearly far enough. Probably the best reason to take Genesis as history is that *Jesus* did! That is, Jesus clearly affirmed the real history of Genesis. He affirmed that God made Adam and Eve "from the beginning of creation" (Mark 10:6), not billions of years afterwards.[26,27] Jesus used the reality of Noah, the Flood, and the Ark to warn of a coming judgement (Luke 17:26–27). He taught that Abel was the first murder victim (Matthew 23:35).[28] Swamidass claims to also believe in Genesis as 'history', but his need to bring the Bible into conformity with secular 'scientific' views causes him to drastically misinterpret that history in ways that clearly contradict what Jesus taught.

Jesus should be preached as the Apostles preached Him. For example, how did the Apostle Paul preach the Gospel? In 1 Corinthians 15:1–4, he summarizes the Gospel, and reminds the Corinthians that this is what he had previously taught them when he first evangelized them about 15 years earlier:

> "Now I would remind you, brothers, of the gospel I preached to you, which you received, in which you stand, and by which you are being saved, if you hold fast to the word I preached to you—unless you believed in vain. For I delivered to you as of first importance what I also received: that Christ died for our sins in accordance with the Scriptures, that he was buried, that he was raised on the third day in accordance with the Scriptures … ."

But note the last phrase, "in accordance with the Scriptures". Paul explains that the Gospel, the 'good news', doesn't dangle rootlessly in a vacuum. To explain the good news, Paul gave the bad news, that we need saving because we are sinners, and where this all began (the reason for the Gospel), when he continued:

> "For as by a man came death, by a man has come also the resurrection of the dead. For as in Adam all die, so also in Christ shall all be made alive. … The last enemy to be destroyed is death. … Thus it is written, 'The first man Adam became a living being'; the last Adam became a life-giving spirit. … The first man was from the earth, a man of dust; the second man is from heaven. … Just as we have borne the image of the man of dust, we shall also bear the image of the man of heaven" (1 Corinthians 15:21–22, 26, 45–49).

So even when preaching the Gospel, Paul firmly grounded this in the first few chapters of Genesis, which he treated as history. Paul explicitly teaches that Adam is 'the first man', not just a genealogical ancestor, as Dr Swamidass believes, although pinning him down on specific definitions of these terms is difficult.[5,6]

Paul explicitly teaches that human death came through Adam. In contrast, Jesus, 'the Last Adam', brought resurrection from the dead. Jesus' resurrection was physical and bodily, to undo the physical, bodily death that arose from the first man, Adam. The evolutionary fossil record, which Swamidass accepts uncritically, teaches that real humans *(Homo sapiens)* have been dying since 315±34 thousand years ago.[7] This clearly undermines Paul's gospel preaching. If death is not the punishment for sin, how could Jesus' death pay the penalty we deserve for our sins (cf. Isaiah 53:6)?

The Apostle Paul also wrote the Epistle to the Romans, the most profound exposition of the gospel in the Bible. Here, Paul again contrasts Adam and Jesus—Adam brought sin and death; Jesus brought righteousness and life:

> "Therefore, just as sin came into the world through one man, and death through sin, and so death spread to all men because all sinned … . Yet death reigned from Adam to Moses … . But the free gift is not like the trespass. For if many died through one man's trespass, much more have the grace of God and the free gift by the grace of that one man Jesus Christ abounded for many" (Romans 5:12–15).

Dr Swamidass' theistic evolutionary view undermines the contrast between Adam and Christ that underpins Paul's gospel thinking. Thus, while we agree totally with Swamidass about the need to preach Jesus, we disagree with his implicit claim to know better than Paul about *how* to preach.

Concluding remarks

Swamidass writes:

> "Our entire faith hinges on the Gospel, which is rooted in a factual claim about this historical event in the physical world."[4]

We say amen to this. But keep in mind that Swamidass is an evolutionist who denies that physical death entered through the Fall (he accepts millions of years of evolution with death and suffering prior to the appearance of humans), and who also denies the global Flood of Noah. It is true that the faith hinges on the Gospel, but on what does the Gospel hinge? Only the historicity of the rest of Scripture, starting in Genesis. One cannot simply cherry-pick which parts of biblical history one wishes to believe. Jesus preached and believed in the literal historical truth of the whole body of Scripture, starting in Genesis.[29] Anyone who, like Swamidass, claims to place faith in Jesus as central to their lives, should also do likewise.

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The search for Adam, Eve, and creation in ancient Egypt

Gavin Cox

Noah's third son, Ham, is directly linked to the land of Egypt in Psalms (78:51; 105:23, 27; 106:22), which is called the 'Land/tents of Ham'. Ham would have known about creation, Adam and Eve, and Earth's history up to his generation before the Flood from his father Noah. Ham (who witnessed the Flood) would have received this pre-Flood knowledge via Noah's teaching from writings handed down to the generations from Adam. Post-Babel, Ham would have passed such knowledge onto his descendants in the newly settled Egyptian state, which become increasingly paganized over time. Such knowledge would still include memories of Adam and Eve, the etymology of their names, their Fall, and knowledge about creation. I explore those connections in this article, focusing on Egyptian linguistic evidence and inscriptions. I conclude that Ancient Egypt knew of Adam and Eve and worshipped them as gods, and that Egyptian belief in creation is strikingly similar to Genesis at specific points.

When it comes to knowledge about creation and the pre-Flood world, it is instructive to understand that Genesis reveals the astonishing lifespans of the pre-Flood patriarchs, who lived on average to around 900 years of age. Genesis 5 leads us to the realization that Adam lived at the same time as Methuselah, who in turn lived contemporaneously with Noah.[1] That being the case, it is perfectly reasonable to assume that Noah had divinely revealed knowledge passed on to him about creation, Adam and Eve, their Fall, and 1,656 years of pre-Flood history, which later became the basis of Genesis 1–9. Noah likely received these accounts in written form, handed down to the generations from Adam onwards, which logically accounts for the *toledoth* structure of Genesis 1–11.[2] From the biblical evidence provided, I formulate hypotheses 1–8 (figure 1). I will investigate these predictions—that Ancient Egyptian religion contains knowledge about creation (1), Adam and Eve's names (2, 8), and their Fall, which is comparable to the account in Genesis 1–3.

Ham's line became pagans

Ham dishonoured his father (Genesis 9:22, 24) resulting in Noah's blessing of Shem and Japheth (Genesis 9:25–27). Noah's curse was specifically placed on Ham's son Canaan. Scripture remains silent regarding any blessing on Ham's descendants in general, including the Egyptians, through Mizraim (Genesis 10:6). From the archaeological and textual evidence examined in this article, all evidence points to Ham's posterity paganizing the creation and Flood knowledge handed on from Noah.

Prediction 1. Creation concepts, equivalent to Genesis, will appear in Egyptian paganized religion.

Prediction 2. The names of Adam and Eve should appear together as a discernable couple.

Prediction 3. Adam will be connected to Egyptian ideas of the Flood (see later explanation).

Prediction 4. Knowledge of creation, Adam, and Eve will occur in Egypt's oldest inscriptions, including the most significant textual corpus, the 5th Dynasty Pyramid Texts (PT).

Prediction 5. Deified ancestors: Adam as a deified ancestor will be discernable in Egyptian religion.

Prediction 6. Pharaonic references: Adam as the first living human being should be an important concept, and so would be expected in Pharaonic inscriptions.

Prediction 7. Temple and worship: if Adam was worshipped in Egypt, evidence of a temple/s and worship dedicated to him will be expected.

Prediction 8. Meanings of Adam and Eve's names should be preserved in Egyptian onomastics, when compared to their biblical Hebrew names.

A brief overview of Egyptian cosmogonies

Ancient Egypt had three main beliefs about the origins of the gods and creation. These arose in three separate locations in Egypt, each with its own worship centre. Known by their Greek names: Heliopolis (located within present-day Cairo), Memphis (20 km south of Cairo), and Hermopolis (323 km south of Cairo).[3] These Egyptian creation beliefs all shared common ideas: concepts of a primordial ocean, a primeval hill, and nature as divine.[4] A fourth theology focuses on the creation of humanity, centred around a temple on the island of Elephantine at Aswan (870 km south of Cairo) which

Figure 1. Eight hypotheses based on implications of Genesis history

described a creator god called Khnum.[5] For this study the cosmology centred in Heliopolis is of particular interest.

Heliopolitan theology

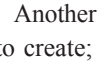
The Egyptian city of Heliopolis[6] was a regional centre of Re-Atum worship from pre-dynastic times. An important surviving remnant of Heliopolis is the Temple of Re-Atum obelisk, a 68 ft (20.73 m) high red granite obelisk (weighing 120 tons), erected by Senusret I of the 12th Dynasty.

Texts inscribed in 5th Dynasty pyramids describe Atum, the first creator god, who emerged from the primordial flood waters (called Nun) ascended the primordial hill (the first land of creation) and initiated the work of creation (PT-1248).[7] PT-1652 and PT-1653a describe Atum 'sneezing' or 'spitting out' two offspring deities, a son called Shu (representing the air) and a daughter called Tēfnut (representing moisture). From these two, other gods were believed to have descended by natural procreation. This is described in the Great Amun Hymn which states: "The living gods who came forth from Re[-Atum], the Ennead, the children of Atum".[8] The Great Ennead of Heliopolis were nine primeval gods descended from Atum. However, Egyptologist David Silverman points out: "Quite often, the traditional Ennead includes a tenth god, usually Horus... or Re (the sun)".[9] PT-1655 lists the Enneads' names: "Atum, Shu, Tefēnet, Gēb, Nūt, Osiris, Isis, Seth and Nephthys."[10] For this study, the identity and meaning of the first creator deity, Atum, is of particular interest, who will be discussed later. It is also instructive to recognize that after Adam there are a further nine generations to Noah, which may be reflected in the 9 generations of the Ennead, although this is speculative.

Egyptian creation belief vs Genesis 1

Some intriguing literary connections between Egyptian and Hebrew cosmology have been demonstrated by scholars.[11] Genesis 1:1 contains the Hebrew word רֵאשִׁית (rēʾšîṯ) "beginning, first, starting point" (*HALOT*-8618) which describes the initiation and moment-in-time of God's creative act. The Hebrew root of this word is: רֹאשׁ (rōʾš) "head, chief" (*HALOT*-8602). The exact parallel is seen in the Old Kingdom (OK) Egyptian word *sp-tp.i* "first occasion; primeval times" (*Wb* 3, 438.1–6; 5, 278.3–4). The hieroglyphic sign (note the ideograph for head) is: // .

It should be recognized that, just like the Hebrew word for 'beginning' (and a number of Semitic and Afro-Asiatic languages), the Egyptian word *sp-tp.i* is derived from the Egyptian root *tp* meaning "head, beginning; chief" (*Wb* 5, 263.3-265.10; 266.5–6, 7–11). The hieroglyphic sign (note the ideograph for head) is:  . Egyptologist James Hoffmeir recognizes these similarities, and that in both the Egyptian and Hebrew understandings "creation marked the beginning of time".[12]

Another example is the OK term, *kmȝ* () meaning "to create; to produce; to devise" (*Wb* 5, 34.3–36.5). This word shares its root with *ḳmȝ* () an OK word, meaning "to hammer out (metal)" (*Wb* 5, 36.16–37.6). OT theologian John Currid has noticed the exact parallel between the Egyptian words for create with the Hebrew words used in the creation account.[13] On day two of creation (Genesis 1:6–8) God created the heavens. The Hebrew word רָקִיעַ (rāqîᵃᶜ) is used, which means "sky, firmament" (*HALOT*-8991). This word shares its root with רקע (rāqᵃᶜ) which in the Peil and Pual stems means "hammered, beaten flat, a metal sheet" (*HALOT*-8998) a word associated later with metalworking. The Hebrew, like the Egyptian cosmology, portrays God as the master craftsman, constructing the heavens. However, neither the Bible nor the Egyptians thought in terms of a solid, metal-domed sky,[14] but rather one of divided waters.

Genesis 1:6–9 describes God separating the waters to create an 'expanse' and gathering of waters together, so dry land could appear. Similar Egyptian cosmological beliefs can be discerned, whereby separation is a key motif in creation.[13] For instance, Coffin Text (CT) 80.39 describes Atum's mode of creating the cosmos "when he separated Geb (the earth-god) from Nut (the sky-goddess)."[15] Currid discusses the Leiden Stele, which exults Ptah as "the great god who separated the sky from the earth." He points out that Genesis 1 uses the Hebrew verb *bādal* meaning "to separate" five times to describe God's creative activity. Currid recognizes this motif also appears in the Egyptian creation myths "A parallel exists here. That is to say, both civilizations believed that

the separation of natural phenomena was an expression of the creative act."[13]

How do we explain the similarities?

What should we make of parallels between Egyptian theological terms and concepts for creation, (pre-Hebrew occupation) and their similarities to the Hebrew Bible? OT theologian Gordon Johnston recognizes Genesis 1 "clearly rejects the Egyptian polytheistic deification of the sky, ground, and air. It does not, however, dramatically distance itself from Egyptian cosmic geography."[16] Currid suggests the parallels can be understood in terms of Hebrew polemics, i.e. the Genesis creation account was written, in part, to critique the Egyptian theologies.[17] These scholars are correct to see the similarities, but Scripture was not written primarily to critique pagan thought. God's Word as inspired, historical truth, by its very nature, would challenge later pagan thinking. Scripture was not merely competing for attention in the marketplace of ideas in the Ancient Near East (ANE). Rather, the similarities of ANE thinking with Scripture should be seen in terms of pagan religions borrowing or corrupting biblical concepts.

Specifically, for this study, Ham took with him into Egypt knowledge of creation and Adam and Eve, passed on from Noah, and Ham's first-hand experience of the Flood. Therefore, deep connections between the Bible and Egyptian ideas of creation and the Flood should be expected, despite Ham's descendants' paganism. From a historical, biblical perspective, this is a better way of explaining why there are parallel Egyptian concepts of creation compared to Genesis.

Egyptian concepts of the breath of life and image of God

Genesis 1:27 describes God creating humans in His image, and imparting life to Adam when He "breathed into his nostrils the breath of life" (Genesis 2:7). These specific aspects of creation are clearly developed in Egyptian religion. For instance, the 10th Dynasty (c. 2025 BC) *Merikare* wisdom text (pCarlsberg VI) states that when their god created humans "He made the breath of life for their nostrils. They are his images (*snnw)* which came forth from his body."[18] (*Snnw* means "second, likeness, image" (*Wb* 3, 460.6–17) written using the determinative of a statue (). CT-80.43 states "My life is what is in their nostrils, I guide their breath into their throats."[19] In CT-76.13 Atum is addressed as "you who exhaled the breath which is in the mouth of Shu,"[20] revealing divine breath as integral to the Egyptian concept of human creation. Currid correctly points out "No similar doctrine is known among the Babylonians or Sumerians."[21] The Egyptian motif of divine breath imparted to creation is widespread, a motif even transferred to the Pharaoh.

Image: Roland Unger/CC BY-SA 3.0

Figure 2. Relief from birth temple at Dendera. Khnum moulds a living being, accompanied by the frog-goddess.

Origin of death—Eden vs Egypt

Genesis 1–2 describes the pre-Fall creation, where no death or suffering existed, which parallels Egyptian ideas. Later cosmogonic demotic texts[22] (Carlsberg papyri 5) describe a 'Golden Age' in primeval world history, when the Ogdoad[23] reigned, during times of "peace and joy", when "crocodiles did not seize and serpents did not bite".[24] The texts allude to death's origin: "Death came into existence, flying to every [pl]ace which is und[er] the sky."[25] In these texts, creation and the pre-Flood world are remembered, but seemingly confused and compressed theologically. Egyptologist Mark Smith who translated the papyri states:

> "This implies that there was a period in the development of the cosmos when there was no death. Similarly, the much earlier Pyramid Text 571 speaks of a time *n hprt mwt*, 'before death came to be'... Kakosy has suggested that death was probably created as a consequence of man-kind's rebellion against the sun god, described in the Book of the Heavenly Cow[26]… . Life is said to have emanated from the Primaeval Ocean [Nu/ Nun], while death is an emanation of a being identified only as 'the serpent'… . The breath of life is what causes all things to live; the breath of death is what causes them to die."[27]

The Egyptian theology at this point strikingly echoes Genesis 1–2 with its pre-Fall paradise, and death associated with the Fall and serpent.

The man of clay

Genesis 2:7 states that Adam was created and "formed" from the "dust of the ground". The Hebrew term יצר (yîṣer) "as a potter to form, fashion" (*HALOT*-3901) is frequently applied to a potter making a vessel from clay.[28] Within Egyptian cosmology, the concept of humanity's creation by the

Table 1. Adam and Eve's Hebrew semantic ranges, by phonetic root

HALOT#	Translit.	Translation	Ref.	Text Example
139	*ʾāḏām*	"man; mankind, people [personal name of first man]"	Gen. 2:7a	"… the LORD God formed the man (אָדָם)…"
147	*ʾăḏāmāʰ*	"earth, from clay, red tilled soil"	Gen. 2:7b	"… of dust from the ground (אֲדָמָה)…"
2102	*dam*	"blood, of man or animals"	Gen. 9:6	"Whoever sheds the blood (דָּם) of man…"
144	*ʾāḏōm*	"red, reddish-brown, blood coloured"	Gen. 25:30	"Let me eat some of that red (אָדֹם) [stew]…"
BDB#	**Translit.**	**Translation**	**Ref.**	**Text Example**
2872	*ḥawwāʰ*	"Eve"	Gen. 3:20a	"… called his wife's name Eve (חַוָּה)…"
3007	*ḥāy*	"alive, living"	Gen. 3:20b	"… she was the mother of all living (חָי)"

gods from clay is clearly developed. For instance, the god Khnum was believed to be the creator of humans, which he formed on his potter's wheel, from clay (figure 2).

Adam and Eve—meanings of their names

My previous articles dealt with the biblical phenomenon of paronomasia (puns), whereby the Hebrew biblical text leaves phonetic markers to connect names with concepts, thereby elucidating their meaning.[29] OT theologian John Wenham states:

> "This play on similar sounding words, paronomasia, is a favorite device of Hebrew writers … phonetic allusions to *ʾādām* "man" have been noted … the whole story reverberates with allusions to the word *ʾādām*, and to the name of Eve *ḥawwāh*, just as the flood story has many puns on Noah's name … ."[30]

Adam's creation from the dust of the ground reveals the 'earthy' nature of Adam. From the Genesis text the phonetic connections can be discerned between "the man" and the "ground" in Genesis 2:7.

> וַיִּיצֶר יְהוָה אֱלֹהִים אֶת־הָאָדָם עָפָר מִן־הָאֲדָמָה וַיִּפַּח בְּאַפָּיו נִשְׁמַת חַיִּים וַיְהִי הָאָדָם לְנֶפֶשׁ חַיָּה׃

> "… then the LORD God formed the man (*āḏām*) of dust from the ground (*ăḏāmāʰ*) and breathed into his nostrils the breath of life, and the man (*āḏām*) became a living creature" (Genesis 2:7).

The name Adam sounds like 'earth' (*ăḏāmāʰ*), whereby a play-on-words (pun) is made in Hebrew to establish semantic and theological connections to Adam's name.[30] Furthermore, 'blood' is connected with Adam's name by the phonetically similar word (*dam*) Genesis 9:6:

> שֹׁפֵךְ דַּם הָאָדָם בָּאָדָם דָּמוֹ יִשָּׁפֵךְ

> "Whoever sheds the blood (*dam*) of man (*āḏām*), by man (*āḏām*) shall his blood (*dam*) be shed …" (Genesis 9:6).

The colour 'red' is a phonetically similar word (*ʾāḏōm*), occurring at Genesis 25:30:

> וַיֹּאמֶר עֵשָׂו אֶל־יַעֲקֹב הַלְעִיטֵנִי נָא מִן־הָאָדֹם הָאָדֹם הַזֶּה כִּי עָיֵף אָנֹכִי עַל־כֵּן קָרָא־שְׁמוֹ אֱדוֹם׃

> "And Esau said to Jacob, 'Let me eat some of the red (*āḏōm*) [stew—this red stew], for I am exhausted!' (Therefore, his name was called Edom [*ʾĕḏôm*])" (Genesis 25:30).

So, within the Genesis text, there are clear phonetic correspondences between the name 'Adam', 'man/ mankind', 'soil/ ground', 'blood' and 'red colour' (table 1). Similarly, the Genesis text leaves phonetic clues to interpret Eve's name, Genesis 3:20:

> וַיִּקְרָא הָאָדָם שֵׁם אִשְׁתּוֹ חַוָּה כִּי הִוא הָיְתָה אֵם כָּל־חָי׃

> "The man called his wife's name Eve (*ḥawwāʰ*), because she was the mother of all living (*ḥāy*)" (Genesis 3:20).

The paronomasia is more apparent when Eve's name is compared to the qal and piel aspects of 'life', i.e. חיה(*ḥayyā*) "to be alive, to revive, to preserve" (*HALOT*-2815) (cf. Deuteronomy 6:24). Wenham states: "The terms *ḥayyîm*, *ḥayyāh* (life, living…) audibly resemble the name of Eve."[30]

From evidence in the Genesis text, the semantic range for Adam and Eve's names are listed by Hebrew phonetic root (table 1).

Table 2. 'Adam' phonetic equivalent Egyptian names

RPN#	**Phonetic equivalent 'Adam' Personal Names**	**Hieroglyph**	**Date**
I, 51.24	*jtm-ḥtp* "Atum is gracious"		NK
I, 399.25	*dmj* (untranslated)		OK
LGG#	**Phonetic equivalent 'Adam' Divine names**	**Hieroglyph**	**Date**
VII, 411 ff.	*tm; tm.w* "Atum"		OK
VII, 426.9	*tmw* "The People"		MK
I, 90.8	*ꜣdmw* "angry, glowing red, red"		OK
I, 611.4	*jtm* "The Eblaite goddess, Adamma"		NK

Prediction 8 expects that via Ham's influence, these phonetic and semantic correspondences for the names of Adam and Eve would have passed into Egyptian language, onomastics, and religion. The following evidence presented here supports this hypothesis and is presented in tables 2 and 3.

Phonetic considerations for Adam and Eve's names

An important question to ask is: Are there phonetic equivalent Egyptian personal and divine names that can be considered equivalent to Adam and Eve's Hebrew names? The following phonetic considerations need to be taken into account in order to accurately identify any potential correspondences:

The initial Hebrew weak consonant *Alef* א in Adam's name corresponds to the Egyptian vowel /i/. The Hebrew *Dālet* ד corresponds to both Egyptian voiced dentals, /d/ and /t/. Linguist Antonio Loprieno explains that evidence "inferred through Coptic, brought these phonemes in the phonetic

Table 3. 'Eve' phonetic equivalent Egyptian names

RPN#	**Phonetic equivalent 'Eve' Personal Names**	**Hieroglyph**	**Date**
I, 425.27	*ḥwj* (untranslated)		OK
I, 232.10	*ḥꜣw* (untranslated)		OK
LGG#	**Phonetic equivalent 'Eve' Divine names**	**Hieroglyph**	**Date**
V, 13.15	*ḥwy, ḥꜣy* "The Flood"		Grk-Rom
V, 13.16	*ḥꜣy* "The naked one"		NK
V, 14.3	*ḥꜣw* "bird of prey"		MK
V, 54.6	*ḥwwy* "The two *ḥw*-gods"		MK

Table 4. Egyptian vocabulary containing phonetic '*tm, dm*' root words

Wörterbuch#	Egyptian	Translit.	Translation	Date
V, 453.1		*dmꜣ*	"to clot [blood]"	OK?
I, 153.14-18		*ỉdm.ỉ, dmỉ*	"high quality; red linen"	OK
GDG[35] I, 126.2, 128.1		*ỉdm*	"Edom"	NK
V, 369.4		*tmḥ.y*	"red ochre"	NK
V, 305.7-16; 308		*tm.w, tmm*	"everyone; humankind"	NK
V, 305.3-6		*tm*	"everything"	OK
V, 308.2-3		*tmꜣ.t*	"ancestress; mother"	LP

proximity of Semitic emphatics: most likely /d/ = [t']."[31] Linguist Orel Vladimir also noted:

> "The Hamito-Semitic [HS] dental emphatic [*ṭ] was not preserved as such in Egyptian. In several cases, etymologically sound comparisons imply its development to *t* while other valid and traditionally accepted etymological equations are based on its change to *d*. Comparisons based on older Egyptian forms show a complicated but perceptible complementary distribution in which several factors are of decisive importance. Generally speaking, in the anlaut [first sound of a word] HS *ṭ- yields to Egyptian *t-* while elsewhere it develops to Egyptian *-d-*."[32]

Lastly, the terminal Hebrew *Mēm* ם in Adam's name is phonetically equivalent to the voiced bilabial Egyptian /m/. With these phonetic considerations in mind the following nearest phonetic equivalent Egyptian personal and divine names bearing the strong bi-consonantal roots dm and tm are presented in tables 2, 3.

RPN[33] records 5 *tm* personal name variations and 9 *dm* name variations, phonetically equivalent to Hebrew Adam. *LGG*[34] records multiple examples of *tm* and 2 *dm* divine name variations.

Eve's name: phonetic considerations

For Eve's name, the initial Hebrew *Ḥēth* ח is equivalent to Egyptian voiceless pharyngeal fricative /ḥ/. The middle Hebrew *waw* ו is equivalent to Egyptian /w/. The terminal Hebrew *Hē* ה is equivalent to Egyptian voiceless glottal fricative /h/, but in the word-final position, is used to indicate the Hebrew 'a'-vowel, equivalent to Egyptian vowels /j/, /y/ or

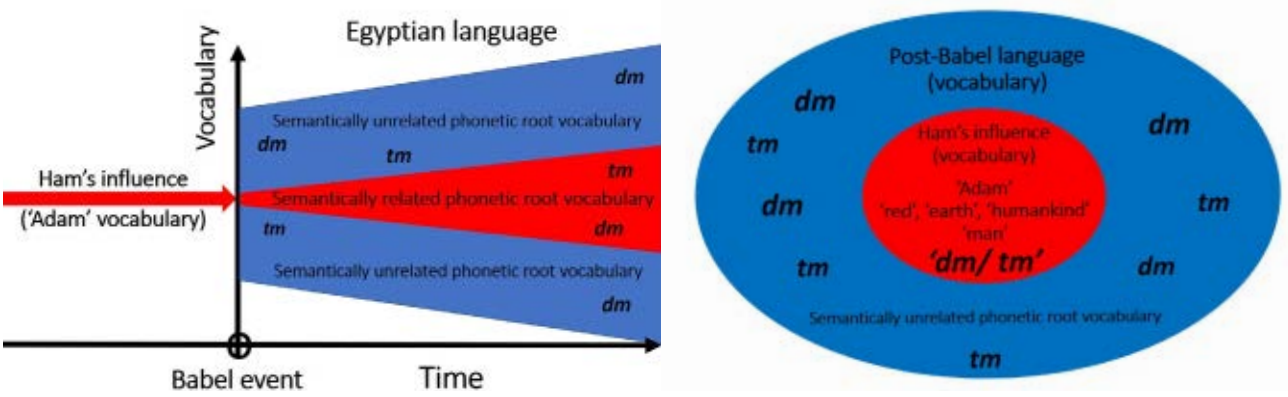


Figure 3. Ham's influence on Egyptian language and religion (Adam vocabulary)

/w/. Table 3 lists Egyptian personal and divine names phonetically equivalent to Hebrew Eve.

The *RPN* Egyptian Lexicon lists 7 personal names that phonetically match Hebrew Eve, specifically, 3 *ḥwj* and 4 *ḥɜw* name combinations. *LGG* records multiple examples of *ḥwy*, *ḥɜy* variant divine names.

Do Egyptian names demonstrate equivalent semantic ranges compared to Hebrew Adam and Eve?

Clearly, there are phonetically equivalent personal and divine Egyptian names compared to Hebrew Adam and Eve. However, can it be demonstrated these names carry equivalent semantic ranges when compared to the meanings of Adam and Eve's Hebrew names? Table 4 offers evidence consistent with this hypothesis:

Image: Hajor/CC BY-SA 3.0

Figure 4. Re-Atum killing Apophis at the Ished tree, tomb of Inherkau (from kairoinfo4u[43])

Discussion of results

A *Thesaurus Language Aegyptiaca* (*TLA*) search for words containing *tm* phonetic roots was made, returning 33 words, and *dm* returned 31 words. Table 4 lists 8 words dating from OK to Late Period (LP) that match the semantic range of Adam's Hebrew name. The Egyptian root *tm*, like the Hebrew root for Adam, *dm*, is shared by NK words *tm.w*, *tmm* "everyone; humankind", which points back to OK *tm*, "everything". Phonetically equivalent OK words include: *dmɜ* "to clot (blood)", *dmi̯* "fine red linen", NK *tmḥ.y* "red ochre", and *i̯dm* "Edom". Divine OK names occur: *ɜdm* "*Adm*, Ademu, a divine being" meaning: "red, glowing red, angry" (Pepis I, II, PT-689). Significantly, the root *tm* is also shared by the first god named within the Ennead (group of nine gods), specifically, "Atum" (*tm*; *i̯tm.w*), whose name appears as far back as the 5th Dynasty Unas PT-215–219.

The examples demonstrate the Egyptian equivalent name 'Adam' possesses a phonetic value and semantic range like biblical Adam, evidence supporting the hypothesis that Ham influenced Egyptian language, onomastics and religion (figure 3).

However, for the nearest Egyptian phonetic equivalent names for Eve: *ḥwj, ḥɜw, ḥwy, ḥɜy*, I found no evidence that these roots occur in Egyptian words sharing the semantic range of Hebrew Eve. Therefore, the name was either lost within Egyptian history, or these words are unrelated. Nevertheless, the female version of Atum, *tmɜ.t*, means "ancestress, mother" which is equivalent to the title given to Adam's wife Eve in Genesis 3:20.

Representative OK text examples sharing *dm, tm* roots in context

NK, oToronto A 11, [vs. 11]: Letter from Ini-heret-chau to Vizier Chay
<r> ḏi.t rḫ pɜy = j nb sty qmj qnj ɜw, t-jb tmḥ
"For information to my gentleman: ocher, resin, yellow dye, rush red, red ocher … ."

OK, Giza, East Field, Mastaba of Khafkhufu I (G 7130, 7140), facade (line [5])
snṯr jdm
"Frankincense, red linen fabric … ."

NK, pLondon BM EA 10477 (papyrus Nu), Tb 145 (line [8])
jw = j rḫ.kw rn n tmm.w tp, jw-ɜ gbb
"I know the name of humanity before Geb."

pBrooklyn 47.218.84
sms wn = [f] … tmɜ.t = [sn]
"The eldest was… [their] Mother … ."

Pyramid Pepis I, PT 689§2090b
ɜdm […]
"Ademu [you who rage as Sobek (?)]"

Adam, tree, and serpent vs Atum, tree, and serpent

Genesis 3 narrates the account of the Fall of Adam at the tree of knowledge in response to the serpent's temptation. Ham would naturally have known of this account from his

Figure 5. Atum (seated top left), Thoth (standing far right) and Sheshat (standing, middle) writing the length of the reign of the king, Ramesses II (seated middle), on leaves of the Ished tree. (After Ernst Weidenbach 1818--1882.)

father Noah. Does Egypt have a discernably similar account involving Atum? The answer is a resounding yes.

Egypt's evil serpent *par excellence* is called Apophis (appearing in inscriptions from the 21st century BC). Apophis was considered the most dangerous of the 'chaos monsters' who threatened divine order—he was the counterpart of the creator god.[36] The Egyptian Book of the Dead of Hunefer (c.1280 BC) contains an illustration of Ra (Re)-Atum, as the "Great Tom Cat" (a natural enemy of snakes) battling and crushing/decapitating the head of Apophis, under the sacred *Ished* tree; "growing in Heliopolis that was linked to the destiny of all beings".[37] Similar images appear in 20th Dynasty tombs (figure 4). The myth was subsequently enacted by priests who made models of Apophis which were trampled, stabbed, and burned.[38]

Within the Genesis text, the curse is pronounced specifically upon the serpent's head, which would be "crushed" (Genesis 3:15).[39] There are clearly some remarkable links here with the Genesis account. However, the Egyptian version may designedly polemicize the Genesis account, by having Atum be victorious over the serpent, in which case Ham's descendants corrupted the story.

Eden's tree of knowledge versus Egypt's Ished tree

The Ished tree,[40] like Eden's tree, was related to knowledge. This can be demonstrated from reliefs from the Ramesseum at Thebes (c.1300 BC), which picture Thoth (the god of wisdom) seated on a throne and Sheshat, (a goddess of writing, known as "foremost in the library") accompanied by Atum writing on the leaves (figure 5).The purpose was to fix "the length of a king's reign by inscribing his name on the leaves of the Ished tree at Heliopolis".[41] Ished fruit appear in OK tomb wall inscriptions at Giza, within listings of food provisions for the afterlife. Like Eden's tree of knowledge, concepts of length of life (reign of the king), and wisdom are combined in Egypt's Ished tree. After killing Apophis, Atum split the Ished tree in two,[42] perhaps reminiscent of Eden's twin trees—life and knowledge (Genesis 2:9).

NK, pLondon BM EA 10477 (pNu), Tb 017 (line [60])

"I am the great cat [Atum] on whose side the Ishdet [Ished] tree was split in Heliopolis, on that night of fighting and guarding the wicked and on the day on which the enemies' enemies were destroyed."

Ished 'sounds like' tree of knowledge in Hebrew

וְעֵ֣ץ הַחַיִּ֗ים בְּתֹ֙וךְ֙ הַגָּ֔ן וְעֵ֖ץ הַדַּ֣עַת טֹ֥וב וָרָֽע׃

"…the tree of life also in the midst of the garden, and the tree of knowledge of good and evil" (Genesis 2:9).

Eden's "tree of knowledge" in Hebrew עֵץ (ʿēṣ) (*HALOT*-7205 "tree") and דַּעַת (daʿaṯ) (*HALOT*-2138 "knowledge, discernment, understanding" sounds phonetically like the OK spelling of Ished (*išd.t*) (*Wb* 1, 136.13) (). The name likely derived from Ham, which later became corrupted, but was faithfully preserved in Genesis 2:9. (The theoretical corruption of *ēṣ daʿaṯ* > *išd.t* may have followed this simple path: phonetically, 'tree' and 'knowledge' became fused. The voiceless alveolar affricate /t͡s/, written in Hebrew as Tsade (ץ), shifted phonetically to Egyptian voiceless sibilant *š* (ṣ > š). The voiced epiglottal stop, marked in Hebrew as Ayin (ע), was expressed as an Egyptian vowel, and not being marked in hieroglyphs, was possibly dropped.

Conclusion

This article briefly surveyed several intriguing connections between Egyptian cosmological belief and biblical creation. Egypt's Heliopolitan creation theology had Atum as its chief deity, who emerged from the Primeval waters of Nun and generated nine gods (Ennead), reminiscent of the nine generations from Adam to Noah. Adam's Hebrew name by its semantic range and phonetic value is equivalent to Egyptian Atum, *jtm*. Atum had a female consort *tmɜ*.t, meaning "ancestress, mother", equivalent to Hebrew Eve "mother of all living" (Genesis 3:20). Mythology surrounding Atum offers striking similarities to the biblical Fall narrative.

Atum crushing the serpent's head by the Ished tree closely parallels the biblical creation narrative of the Fall of mankind by the serpent's temptation. The OK spelling Ishdet is strikingly similar to the Hebrew "tree of knowledge". The evidence presented here is consistent with Ham influencing Egyptian belief and language at fundamental levels and fulfills hypotheses 1–8.

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Ice core oscillations and abrupt climate changes: part 2—Antarctic ice cores

Michael J. Oard

The uniformitarian age of the Antarctic Ice Sheet has increased greatly and is believed to have originated in the Oligocene, based mainly on ice-rafted debris in deep-sea cores. In a debate with Ken Ham, Bill Nye thought that the East Antarctic Ice Sheet could be dated by annual layers to 680,000 years ago. No annual layers are recorded in this ice sheet. The two West Antarctic ice cores were analyzed, which are very similar to the ice cores on Greenland. The newest WAIS (West Antarctic Ice Sheet) Divide ice core did not even show a complete section during the Ice Age. The East Antarctic ice cores, showing what are interpreted to be multiple ice ages, are much different from those on West Antarctica. An isostatic correction was applied to each ice core to determine the elevation of the bedrock at the start of the Ice Age. The East Antarctic ice cores are dated by simply 'wiggle matching' to oxygen isotope oscillations in deep-sea cores, which are dated by assuming the astronomical or Milankovitch mechanism of the 'ice ages'. Millennial-scale oscillations, correlated to deuterium isotope ratios, are also measured in Antarctic ice cores. These 'abrupt' climate changes are of small amplitude with a slow rate of change. There are also about ⅓ as many than observed in Greenland ice cores.

Part 1[1] analyzed the large-scale and small-scale changes in the oxygen isotope ratios in Greenland ice cores. This ratio is believed to be correlated to temperature, although this is a simplification. The changes are correlated with many other variables, such as various chemicals in the ice, e.g. Ca^{2+} and Na^{+}, and gases in the ice core bubbles. The small-scale changes, called Dansgaard-Oschger (D-O) or Heinrich events, were assumed to be millennial-scale radical climate oscillations. The abrupt climate changes were believed to take place in a decade to a few years. This second part will focus on the Antarctic ice cores (figure 1), which have similarities and differences to the Greenland ice cores.

The secular view of the origin of the Antarctic Ice Sheet

Within uniformitarian thinking, the age of the Antarctic Ice Sheet has been controversial and has changed with time. It is really two different ice sheets: the West Antarctic Ice Sheet (WAIS), about half of which developed over mountains and the other half developed over the ocean water in between mountains; and the East Antarctic Ice Sheet. At one time, scientists believed that the ice sheet developed in the late Pliocene and/or Pleistocene,[2] the general secular ice age period, which makes sense within their paradigm. However, the East Antarctic Ice Sheet is now believed to have started developing in the mid-Cenozoic after the so-called Eocene warm period, about 40 Ma,[3] and it reached a steady state at about 15 Ma.[4] This radical change to more than 10 times the previous age is based on what is believed to be ice-rafted debris (IRD) from deep-sea cores dated to that time.[5] Anti-creationist geologist Arthur Strahler challenges creation scientists:

> "Increasing the duration of the Ice Age by a factor of about 10 greatly increases the stress upon the creation scientists, who must compress the events of 15 m.y. into 4,000 y. of post-Flood time."[6]

This is a case of stretching out the secular age based on other data sets.

Such stretching of events further back in uniformitarian time seems to be typical. The marsupials found in the Riversleigh Park of north-west Queensland were at first dated to the Pleistocene, but with time the age was pushed back into the Miocene and even the Oligocene.[7] This was accomplished mainly by the 'state of evolution'. Pushing the start of the Antarctic Ice Sheet into the Oligocene in no way implies that the Flood/post-Flood boundary is in the Eocene or Oligocene of the early Cenozoic. We cannot take the subdivisions of the Cenozoic as absolute time markers in biblical Earth history. Each area must be evaluated on its own merits. The Flood/post-Flood boundary could be the late Oligocene/Miocene for the marsupials in Australia or the early Pleistocene for the millions of mammals buried in the upper sedimentary rocks of the High Plains of the United States.[8]

Bill Nye's mistaken ideas on Antarctic ice cores

In the Ken Ham-Bill Nye debate in 2014, Bill Nye claimed that scientists find 680,000 snow winter-summer layers in some Antarctic ice cores:

> "Let's say we have 680,000 layers of snow ice and 4,000 years since the Great Flood, that would mean we would need 170 winter-summer cycles every year for

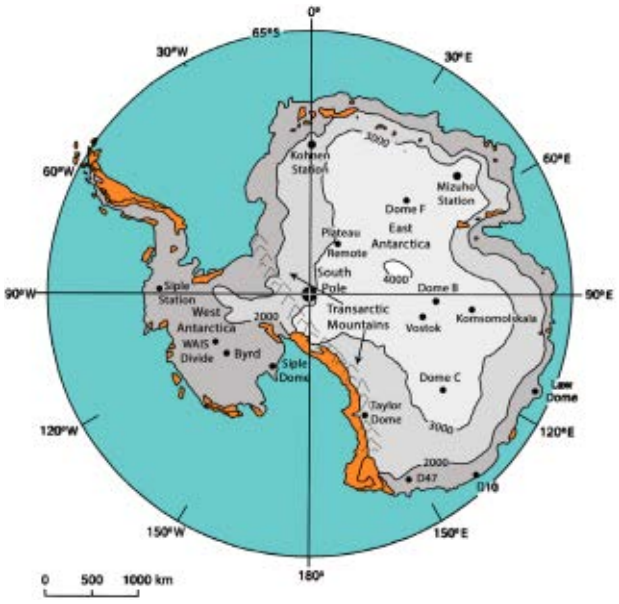

Figure 1. Map of Antarctica showing ice thickness above sea level with major ice core locations

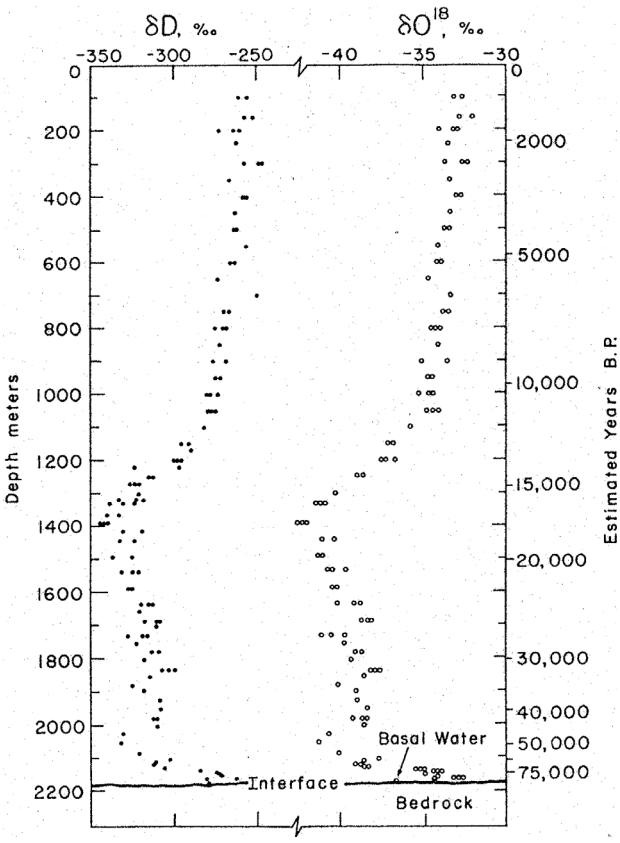

Figure 2. The Byrd, West Antarctica, ice core, showing the change in deuterium and oxygen isotope ratios down the core. The depth is on the left and the assumed uniformitarian timescale is on the right (from Gow *et al.*[14]).

the last 4,000 years. I mean wouldn't someone have noticed that? Wow! Wouldn't someone have noticed that there's been winter, summer, winter, summer 170 times one year?"[9]

He seems to think that creation scientists are really stupid, but maybe he should consider that there may be something wrong with his understanding of ice cores. The quote shows that some secular scientists, like Nye, and probably the general public, believe that the Antarctic ice cores totally demolish the short timescale of the Bible. They must believe also that annual layers are laid down on top of the East Antarctic Ice Sheet and that the Antarctic ice cores show annual layers—clear to 680,000 years. Therefore, the Bible is in error and not to be trusted. However, there is much more to the story.[10]

The top of the East Antarctic Ice Sheet is so high that it is claimed that only about 5 cm of ice equivalent in snow falls each year[11]—much too small for annual layers.[12] Moreover, there are other complications with any presumed orderly accumulation of each year's layer of snow. The snow blows around on top of and on the edges of the ice sheet, so there is much mixing of snow from many years. Glaciologists certainly do not date the cores by counting annual layers as implied by Bill Nye; there are no annual layers in the East Antarctic Ice Sheet! Nye was completely ignorant of the situation.

The deuterium isotope ratio

The deuterium isotope ratio, instead of the oxygen isotope ratio, is mostly plotted with depth in Antarctic ice cores. This is the ratio of the amount of deuterium, with one proton and one neutron in the nucleus of the hydrogen atom, divided by the amount of the hydrogen atom, with just one proton in the nucleus. The deuterium isotope ratio is:

$$\delta D = [(D/H)_{sample} - (D/H)_{standard}]/(D/H)_{standard} \times 1000‰$$

where 'D' is deuterium, 'H' is hydrogen, and δD is measured in per mil, i.e. parts per thousand (‰). Because fractionation of isotopes is proportional to molecular weight, the deuterium isotope ratio changes eight times as fast as the oxygen isotope ratio during evaporation of water. The relationship between the two isotope ratios is expressed by the equation:

$$\delta^{18}O = 8\delta D + d$$

where 'd' is called the *deuterium excess*, which averages 10‰. The deuterium excess can vary around its average value depending upon a number of variables that are related to the moisture source.

The West Antarctic ice cores

First, we will delve into the dating of the West Antarctic ice cores. There are a number of coastal cores, but these are

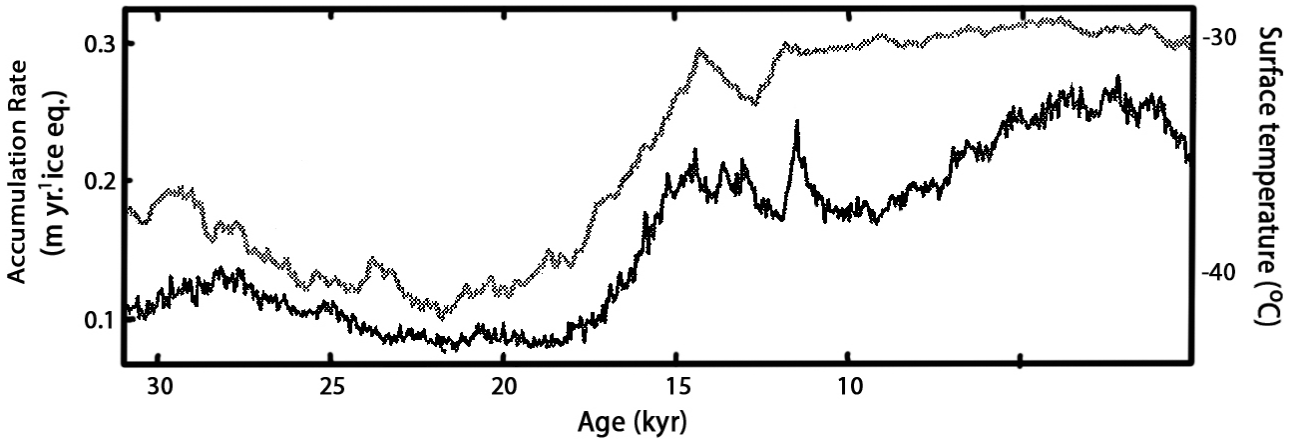

Figure 3. The assumed temperature, based on deuterium isotope ratios, and accumulation rate in m/yr of ice equivalent from the WAIS Divide ice core. The top curve is the temperature and the bottom curve the accumulation rate, believed proportional to the deuterium isotope ratio.

too difficult to interpret.[13] Besides, their timescales are much shorter than those assigned to the central cores and, therefore, are not a big challenge to the creation-science timescale. The Byrd ice core (figure 1) was the second ice core recovered after the Camp Century core in north-west Greenland. It was drilled from 1,530 m above sea level (asl) and reached the bedrock at 2,164 m deep, which is 634 m below present sea level. Figure 2 shows the oxygen and deuterium isotope ratios for this core, with depth on the left and the stretched-out uniformitarian timescale on the right. The top of the core has an annual layer thickness of about 13 cm/yr, thought too thin for annual layers to be visually discerned, since the layers thin with depth. The Ice Age portion of the core is located about 1,300 m down the core, identified by the lower isotope ratios.

A second, long core was drilled on a ridge along the ice sheet divide between ice flowing toward the Ross Sea and the ice flowing toward the Weddell Sea (figure 1). It is called WAIS Divide. It was drilled from the top of the ice at 1,766 m asl down 3,405 m. It was stopped 50 m from the bottom, which means that the core was drilled to 1,639 m below sea level with bedrock at 1,689 m below sea level. However, the ice core reached down only about half way into the Ice Age and was dated to only 68 ka in the uniformitarian timescale. Because of an annual layer accumulation of ice on WAIS Divide of 22 cm, annual layers actually can be determined at the top of this ice core, like in Greenland. Similar to the GISP2 ice core, annual layer counting becomes difficult the deeper in the core, especially since uniformitarian scientists believe the accumulation rate dropped off 50% in the Ice Age (figure 3).[15,16] Uniformitarian scientists simply assume that the accumulation rate is proportional to the temperature, based on deuterium isotope ratios. In fact, the annual layer counting stopped at 31 ka, less than half the total time claimed for the ice core. The annual layers must have been difficult to figure between 15 ka and 31 ka with accumulation assumed to be only 11 cm/yr.

The annual layer counting, whether for WAIS Divide or Greenland, starts with a first guess of the number of annual layers based on assumed equilibrium for millions of years. The flow models take this equilibrium into consideration, which is why the annual layers are believed to thin drastically with depth (see part 1, figure 2).[1] The flow models are also anchored by various tie points of 'known' age with deep time built in. The WAIS Divide ice core even had a 'tie point' from a speleothem in the European Alps![15] Thus, the annual layer counting is very subjective with old age built in.

The section of the core from 31 to 68 ka was simply dated by flow modelling and tie points, and it was matched with the Greenland methane record. This correlation is probably good for finding a common timescale for the hemispheres. Methane mixes relatively fast between the hemispheres, and the ice accumulation generally records the atmospheric methane concentration at the time of accumulation. The same cannot be said for CO_2 since reactions with dust can change the CO_2 in the bubbles (see below). Other tie points came from 'refined' oxygen isotope ratios from speleothems from the Hulu cave, China![17]

The East Antarctic ice cores

The deep ice cores on East Antarctica (figure 1) are much different from those on West Antarctica and Greenland. The East Antarctic Ice Sheet developed mostly over land, some of it is mountainous, and near the South Pole. Whereas the West Antarctic ice cores show only one ice age or just part of one ice age (the WAIS Divide ice core), uniformitarian scientists claim the East Antarctic ice cores indicate multiple ice ages, as shown by large changes in the deuterium isotope ratios. How could the East Antarctic ice cores be so different

from the West Antarctic and Greenland ice cores? This will be answered in part 3.[18]

Figure 4 shows a comparison between the two main East Antarctic ice cores, Dome C and Vostok, according to depth and according to the stretched out uniformitarian timescale. Dome C was drilled from 3,233 m asl down to 3,260 m, stopping 15 m from bedrock.[19] The bottom 60 m was deformed. Therefore, bedrock below Dome C is 3,275 m below the surface at Dome C and 42 m below sea level.

The calculation of ice thickness and isostatic correction for Vostok is tricky. Vostok was drilled from 3,488 m asl and the core reached 3,623 m.[20] It was stopped 120 m above the top of the large, deep, subglacial Lake Vostok, which is about 600 m deep, 230 km long, and 50 km wide. The surface of Lake Vostok is currently about 255 m below sea level. When the ice was first building on Vostok, the lake was frozen at the top, but the weight of the ice would have pushed the ice all the way to bedrock. So, for an isostatic correction, the depth of Lake Vostok, 610 m at this location, must be included. So, adding up the height of the ice sheet above sea (3,488 m), adding the depth below sea level of Lake Vostok (–255 m), and the depth of lake Vostok (610 m) yields a total ice thickness of 4,353 m before the ice melted to form Lake Vostok. Six oscillations are claimed for Dome C from the 1,700 m to the 3,200 m level, while only three are claimed for Vostok from 1,800 m to 3,400 m. The bottom four oscillations of Dome C are of low deuterium isotope amplitude with oscillations between 'interglacials' that are almost as high in amplitude.[21] These glacial/interglacial oscillations are not convincing.

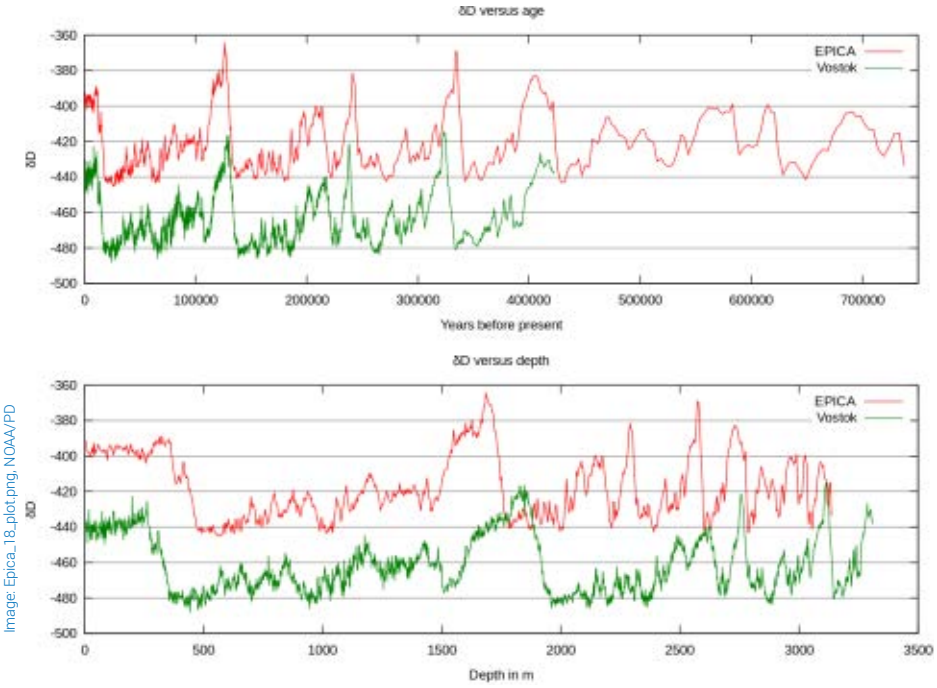

Image: Epica_18_plot.png, NOAA/PD

Figure 4. Plots of the deuterium isotope ratio values (δD) for the EPICA Dome C and Vostok cores with depth (bottom graph) and against uniformitarian 'age' (top graph). The Vostok core is deeper and not nearly as young as the Dome C core. The y-axis offset between Dome C and the Vostok cores in deuterium isotope ratio is real: Vostok is a colder site and has a more negative deuterium isotope ratio.

Two other deep ice cores have been drilled on Antarctica. Dome Fuji or Dome F was drilled by the Japanese from 3,810 m asl down to 2,503 m depth in 1995/96 with an ice thickness of 3,028 m (placing the bedrock at 782 asl) (figure 5).[22] The core stopped 525 m from the bedrock. The scientists found three glacial and four interglacial oscillations down to 2,503 m, dated at 340 ka. Between 2003 and 2007, a second, deep ice core reached 3,035 m to near bedrock, the

Table 1. Calculation of the estimated bedrock elevations above sea level of Antarctic ice core locations before the Ice Age based on an isostatic correction of ⅓ the thickness of the ice

Ice Core	Elevation of ice (m)	Ice thickness (m)	Bedrock elevation (m)	Isostatic correction (m)	Bedrock elevation before Ice Age (m)
Byrd	1,530	2,164	−634	721	87
WAIS Divide	1,766	3,454	−1,689	1151	-538
Dome C	3,233	3,275	−42	1,092	1,050
Vostok	3,488	4,353*	−865	1,451	586
Dome F	3,810	3,035	775	1,012	1,787

*Includes both the thickness of the ice (3623 + 120 = 3,743 m) and the depth of Lake Vostok (610 m), since the isostatic correction needs to include the depth of Lake Vostok.

bottom of which was dated at 720 ka.[23] The large-scale oscillations are very similar to those of Dome C and Vostok.

A fourth deep ice core was drilled at Kohnen Station (Dronning Maud Land), along the downward slope of the East Antarctic Ice Sheet (figure 1). It was drilled from 2,882 m asl and reached 2,417 m deep, the bottom dated at 150 ka and showing one glacial cycle and two interglacial cycles.[25] It was stopped 350 m short of bedrock, 115 m asl, because the ice became deformed further down.[26] Being closer to the edge of the ice sheet, the ice is moving faster, and it is not surprising that the bottom 350 m is deformed.

Isostasy considerations before glaciation

As with the Greenland ice cores, we must determine the bedrock elevation before glaciation to determine the start of glaciation. This is likely a crucial variable in explaining the East Antarctic ice cores. Table 1 presents the current altitude, ice thickness, present bedrock elevation, isostatic correction, and height of the bedrock at the beginning of the Ice Age.

The ice cores from West and East Antarctic can likely be explained by the elevation of the land at the start of the Ice Age, the time it took for the ice to start accumulating, and the ice accumulation rate.

The West Antarctic Ice Sheet would first develop in the mountains, spread to lower altitudes, and then spread over the ocean water between the mountains as ice shelves. Thickening ice shelves from snow accumulation pushed the ice all the way down to the bottom of the ocean expelling the water (see below). Due to the weight of the ice pushing down the land, most of the West Antarctic land surface now sits below sea level. Considering isostasy, the bedrock of the Byrd ice core, now at 614 m below sea level, would have started about 100 m above sea level. Therefore, the Byrd ice core likely did not start accumulating ice until mountain glaciation extended to the lowlands. Thus, the Byrd ice core likely did not develop until about 200 years after the Flood, which likely is why it is similar to the Greenland ice cores.

The bedrock on WAIS Divide, on the other hand, is now 1,689 m below sea level. If we add uplift for isostatic rebound, then this ice core started developing at about 550 m below sea level. In this case, the ice must spread not only from the mountains to the lowlands, but also spread as thickening ice shelves over the ocean water between mountains. This would take more time for glaciation to start at WAIS Divide than at Byrd, maybe in about 300 years after the Flood. This would explain why the WAIS Divide ice core starts toward the middle of the Ice Age. It also explains why no previous ice ages or the warm period before the Ice Age show up at the bottom of the ice core.

If we raise the land of East Antarctica for the time right after the Flood, we would have to raise the bedrock of Dome C to 1,050 m and Vostok to 586 m above sea level (table 1). Based on isostatic recovery, the ice of Dome Fuji would start quite high at about 1,787 m asl. Thus, the higher elevations of East Antarctica would likely have started glaciating within about 50 years with cirques in the mountains.

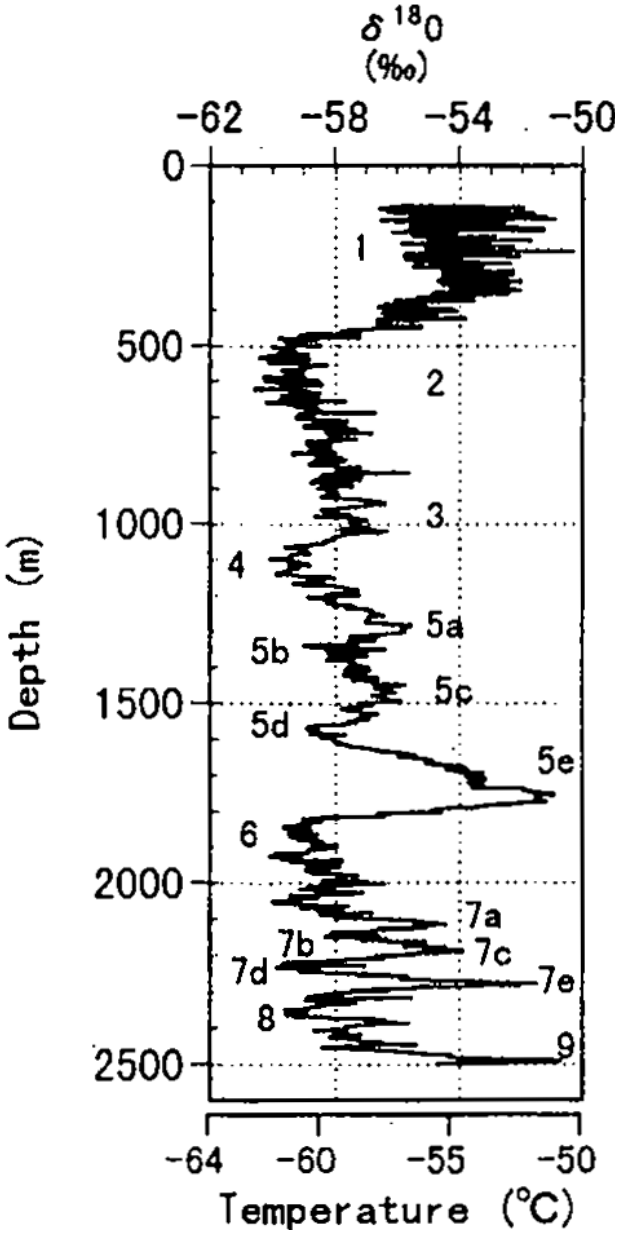

Figure 5. Dome Fuji ice core showing changes in the oxygen isotope ratio, assumed proportional to temperature (from Watanabe *et al.*[24]). The numbers are the Marine isotope Stages (MISs) in which even numbers are glacials and stadials and odd numbers are interglacials and interstadials. Note that the depth is compressed between stage 5e and 9 compared to Vostok, but the top 1,700 m is about the same thickness as both Vostok and Dome C.

Dating East Antarctic ice cores

Since uniformitarian scientists cannot use annual layer counting, how do they date the East Antarctic ice cores? They use 'flow modelling' with the uniformitarian assumptions

built in.[27] Various 'tie points' that have been previously 'dated', such as volcanic signals or glacial/interglacial oscillations, are used to anchor the flow models. They also compare each long ice core to those ice cores already drilled and use wiggle matching,[45] which seems to be okay since the deuterium isotope ratios are consistent throughout the whole East Antarctic Ice Sheet.

The East Antarctic ice cores, as well as many other Quaternary data sets, are ultimately dated by *assuming* the Milankovitch or astronomical theory of ice ages in which glacial/interglacial oscillations repeat every 100,000 years for the 'past' one million years. The Milankovitch theory is built into flow models and the 'dates' of the 'tie points'. So, the dating of the East Antarctic ice cores is simply done by 'wiggle matching' the oxygen isotope ratio, mostly in foraminifera, in deep-sea cores.[28] But this wiggle matching assumes the astronomical theory:

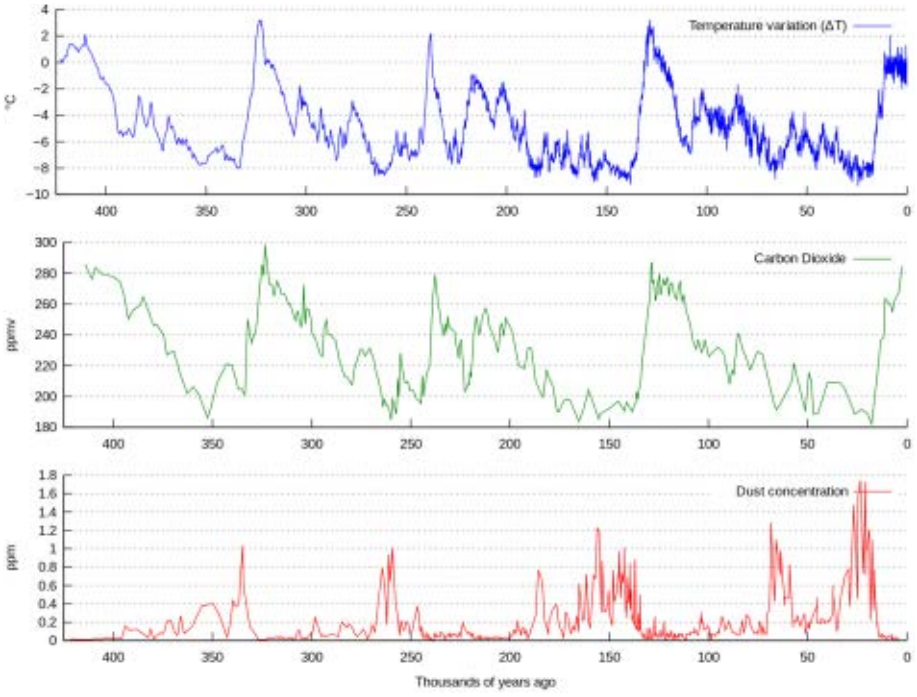

Image: NOAA/CC-BY-SA-3.0)

Figure 6. Graph of temperature change, CO_2, and dust in the Vostok Antarctic ice core to 420,000 years within the uniformitarian timescale

> "Wiggle matching to existing ice core time scales or orbitally tuned [to the astronomical theory] marine records has often been used as a first indication of the age of an ice core, especially for Antarctic ice cores reaching half a million years and more back in time."[29]

Waelbroeck *et al*. also inform us that they matched (tuned) an earlier Vostok ice core, which showed two large oscillations, to deep-sea cores:

> "Taking advantage of the fact that the Vostok deuterium (δD) record now covers almost two entire climate cycles, we have applied the orbital tuning [Milankovitch cycles] approach to derive an age-depth relation for the Vostok ice core, which is consistent with the SPECMAP marine time scale [from deep-sea cores]."[30]

The SPECMAP marine timescale was earlier tuned to the Milankovitch orbital changes:[45]

> "The deep-sea core chronology developed using the concept of 'orbital tuning' or SPECMAP chronology [and] … is now generally accepted in the ocean sediment scientific community."[31]

Nothing has changed over the years. This procedure is circular reasoning. Ice cores, deep-sea cores, and other climatic data sets ultimately all *assume* the Milankovitch mechanism has been 'proven', and that this mechanism is data that strongly influences all climatic data sets. This is also why they can claim there were about 50 ice ages of various intensities during the 2.6 Ma of the Quaternary,[32] based on about 50 Pleistocene wiggles in a composite 'stack' of 57 Milankovitch-tuned deep-sea cores.[33]

However, the 100,000-year Milankovitch eccentricity cycle is very weak, affecting solar radiation extremely little.[34] Moreover, because the uniformitarian scientists changed the date of the Bruhnes/Matuyama normal/reverse transition from 700 ka to 780 ka, the deep-sea core cycles no longer line up with the Milankovitch cycles.[35,36] Therefore, the Milankovitch mechanism, thought 'proven' in 1976 and to be the 'pacemaker of the ice ages',[37] is not proven at all. The secular scientists attempted to quietly rescue the pacemaker paper in 1997, but their efforts are not convincing because of selection bias and a capricious handling of the seafloor sediment data.[38] All climatic data sets that are fitted to this theory are flawed. Ironically, thousands of papers dealing with climatic data sets as well as pre-Pleistocene sediments have a wrong assumption.[39] This means that deep-sea cores and deep East Antarctic ice cores are misdated, even by secular reckoning.

Deuterium isotope ratio correlated to many other variables

The deuterium isotope ratios of the Antarctic ice cores are correlated with many other variables, similar to the situation with the Greenland ice cores. Figure 6 shows the Vostok ice

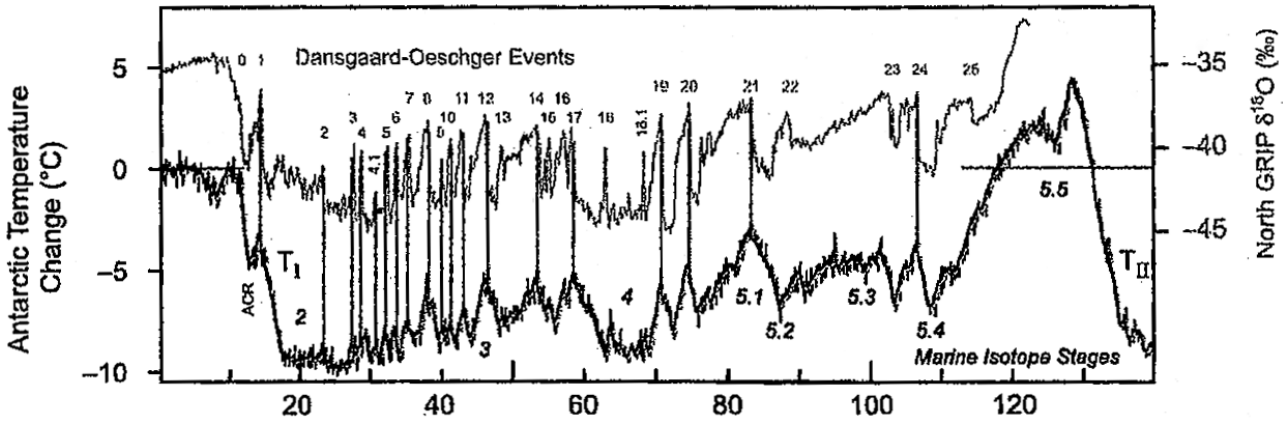

Figure 7. Dome C estimated temperature change, based on δD, for the past 140 ka showing AIMs compared with the D-O events from the North Grip ice core, Greenland, based on $\delta^{18}O$ (from Jouzel *et al.*[46])

core with four claimed glacial/interglacial cycles that are highly correlated to CO_2 with an amplitude of about 100 ppm. However, the CO_2 amplitude was about 30% smaller at Dome C than at Vostok.[40] Moreover, there are big CO_2 differences between Antarctic and Greenland ice cores, which likely is due to chemical effects with dust and acids.[41] We cannot trust CO_2 from the ice cores to correlate between the hemispheres.

The amount of dust is also correlated with the deuterium isotope ratios in Dome C. However, there seems to be little actual dust in the core, and the 'dust' (which is actually volcanic ash) decreases down the core.[42] Narcisi *et* al., state:

> "The Dome C ice is generally very clear and the core contains less than twenty visible dust layers. The majority of these layers occur in the uppermost 2200 m and are composed of airborne volcanic ash produced by explosive eruptions."[43]

Methane, with a maximum amplitude of around 450 ppbv, is highly correlated with deuterium isotope ratios.[21] Seventy-four methane jumps occur in 800 ka, with an apparent rapid increase to the higher values and falling off slowly.[44] Non-sea salt Ca, representing continental sources, and sea salt Na from the ocean are correlated with deuterium isotopes.[45]

Millennial-scale changes

Abrupt climate changes are claimed in the Antarctic ice cores. They are called AIMs (Antarctic Isotope Maximums), but they represent warming of only 1–3°C, much less than those claimed for the Greenland ice cores. Moreover, these smaller-amplitude oscillations do not show an abrupt rate of change, but a more gradual change. The last oscillation before the Holocene is the Antarctic Cold Reversal (ACR). It is questionable whether AIMs can be considered abrupt climate changes.

Furthermore, there appear to be only about 7–9 AIMs in the West Antarctic and East Antarctic Ice Sheets, about ⅓ the number of D-O events in Greenland ice cores (figure 7). Of course, there are numerous other fluctuations of amplitude less than about 1°C, and uniformitarian scientists attempt to also correlate these small fluctuations to D-O events. The average isotope ratio of the seven AIMs decrease up core, probably representing cooling with time, until the Last Glacial Maximum (LGM) was reached.

Conclusions

The Antarctic Ice sheet is now believed to have started about 34 million years ago and reached equilibrium about 15 million years ago. This does not mean all rocks classified as Cenozoic are post-Flood; it depends on how uniformitarians have done their classification. Although Bill Nye claimed in his famous debate with Ken Ham that secular scientists have counted 680,000 annual layers in the East Antarctic Ice Sheet, there are no annual layers in that ice sheet. The two ice cores drilled on the West Antarctic Ice Sheet are very similar to those on Greenland, the newer WAIS Divide ice core not even recording a full glacial cycle. The ice cores on the East Antarctic Ice Sheet are much different, showing up to eight ice ages through the cores to near the bedrock, based on large deuterium isotope fluctuations. However, all ice cores are dated by flow modelling, using 'tie' points, dated from other data sets of 'known' age. This is how deep time enters into ice core dating. But ultimately, the East Antarctic ice cores are dated by wiggle matching to each other and to deep-sea cores. The latter have been dated by assuming the 100,000 ka Milankovitch cycle. Unfortunately for secular scientists, this Milankovitch oscillation changes the solar radiation distribution on Earth extremely little. There is no forcing for climate change. The Antarctic ice cores show what are interpreted to be millennial-scale oscillations that are correlated to many other variables. However, these so-called abrupt climate changes amount to only 1–3°C oscillations, and there are about ⅓ of them as observed in Greenland ice cores.

Part 3[18] will show how the large-scale, isotopic ratio oscillations and all the correlated variables in the all the ice cores can be explained within the biblical Ice Age model. Part 4[47] will provide an explanation for the millennial-scale oscillations and their correlated variables. Part 5[48] will delve into the mystery of the green, wet Sahara Desert that occurred after Northern Hemisphere glaciation.

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Geochemical and related evidence for early Noah's Flood year

Harry Dickens and Aaron Hutchison

This paper proposes a five-stage time sequence for the early part of Noah's Flood year, with an emphasis on geochemistry. Early Flood year processes include the fountains bursting forth, enormous rain, and sea level rise. The Neoproterozoic to Cambrian stratigraphy of the Mackenzie Mountains of north-west Canada is well described in the literature. This location is used as a key example of strata inferred to have formed during the early Flood year. Neoproterozoic stratigraphy is subdivided upwards into Tonian, Cryogenian, and Ediacaran strata.

Early Flood year geological activity included major volcanics, huge amounts of continental erosion, deposition of sheet sandstones, mass flows, banded iron formations with high phosphate content, high volumes of nutrients, and the burial of diverse marine invertebrates. Chemical parameters used in this study include $^{87}Sr/^{86}Sr$ ratios, oxygen levels, lithology types, carbon isotopes, carbonate formation, the order of precipitation of barium and iron, phosphorus levels, sulfur isotopes, organic matter burial, and molybdenum isotope ratios.

Explaining the cause-effect relationships of the rock record at the interface between the Precambrian and Phanerozoic rocks is a complex task:

> "Determining the geodynamic causes of extensive Neoproterozoic continental denudation followed by Phanerozoic sedimentation, and linking those dynamics to the timing and spatial distribution of marine transgression and biogeochemical change, is now a challenge for geoscience."[1]

This paper seeks to address this challenge by invoking a framework of the early stages of the Flood year based on correlating inferred common geochemical processes to the biblical and geological records. Therefore, geochemistry should help clarify events and processes operative during the early phase of Noah's Flood year.

An anticreationist geologist said:

> "Sedimentation in the past has often been very rapid indeed and very spasmodic. This may be called the Phenomenon of the Catastrophic Nature of the Stratigraphical Record."[2]

Many chemical reaction rates increase exponentially with increasing temperature.[3] As such, chemical reactions can occur very rapidly under conditions such as hydrothermal activity. Even at room temperature, many chemical precipitation reactions necessary for mineral formation occur almost instantly.[4] The rapidity of the basic chemical reactions involved is consistent with a young-earth creationist understanding of Earth history.

Broadly speaking, the initial Flood deluge would have caused enormous erosion of the land, and concurrently the sea level rose until eventually all the earth's land was covered.[5] This initial enormous erosion of land is an important aspect of the Flood year that must be recognized in conjunction with the marine transgressions of the Flood year.[6] The Cordilleran stratigraphy of North America, and particularly the Mackenzie Mountains of Canada published by such researchers as Colpron *et al.*[7] (figure 1) and Hoffman and Halverson[8] (figure 2), serve as a good illustration of how these processes could rapidly form Neoproterozoic to Cambrian strata during the early stages of the Flood year. The abundant published studies written on this region that have geochemical relevance make it an especially useful example for closer analysis.

Discussion

The following is a proposed Flood model for the Mackenzie Mountains (figure 1) in five stages in approximate time order for the early Noahic Flood year. We maintain that the generally accepted secular deep-time 'radiometric ages' used in this paper are not absolute ages. In addition, we assert that the events described occurred some thousands of years ago, but in similar order as the referenced radiometric dates.

Stage 1

A. Pre-Flood sediments

The stratigraphic section of the Tonian Mackenzie Mountains Supergroup adapted from Hoffman and Halverson[8] (figure 2) illustrates how the supergroup likely represents pre-Flood deposition in a large epicratonic basin[9] (Stage 1[10]). Detrital zircon provenance studies indicate that the Katherine Group quartz arenite was in part delivered by a continent-crossing early Neoproterozoic river system draining the mountains of Grenville Province in the south-east of North America.[11] The Little Dal Group has giant microbial

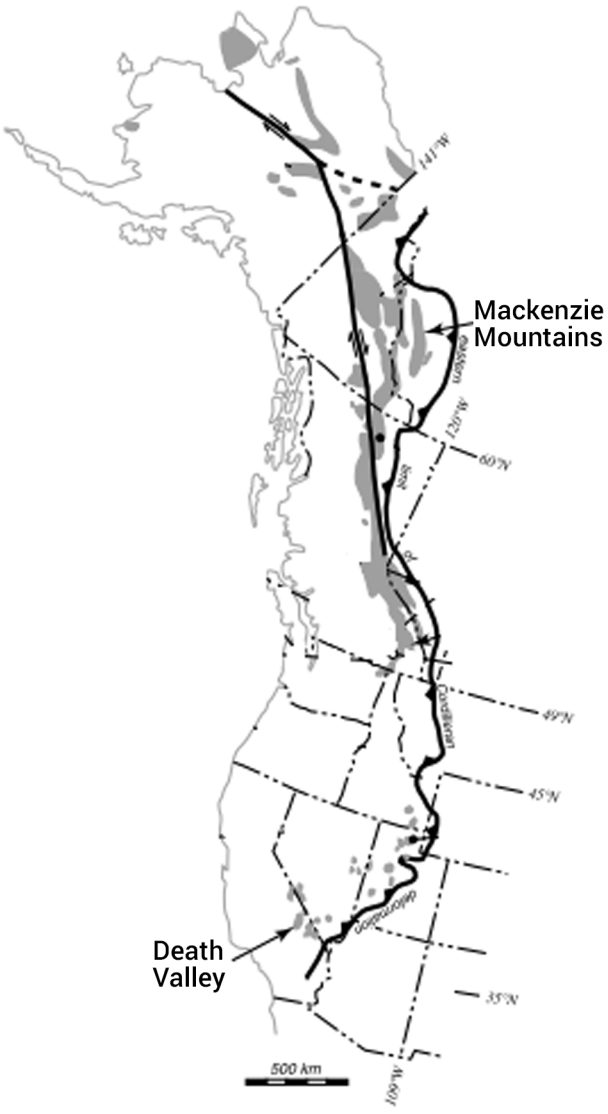

Figure 1. Distribution of late Neoproterozoic strata in western North America, showing the location of the Mackenzie Mountains in north-west Canada (after Colpron *et al.*[7])

carbonate reefs,[9] and the presence of sulfate 'evaporite' indicates the action of hydrothermal springs. These features suggest the presence of a hydrothermal biome on the pre-Flood continental shelf.[12]

B. Initial tectonism and volcanism

Consistent with Genesis 7:11 and Proverbs 3:20a, Noah's Flood may have been initiated by God causing the mantle to heat in a cataclysmic global thermal-tectonic episode, cracking open the earth's crust and driving out water to the earth's surface. Secular scientists have found evidence of episodic rifting events at the margins of North America between 0.8 and about 0.6 Ga. These are thought to record the fragmentation of a Neoproterozoic supercontinent.[13,14] This is consistent with the breaking open of the crust by the fountains of the great deep, followed by further continental extension and then ocean formation.

Mafic volcanic rocks record widespread igneous activity during regional rifting along western North America[10] and the Cryogenian breakup of the supercontinent. Researchers have inferred that large continental flood basalts were emplaced when the supercontinent began to break up. A major example of this volcanism is northern Canada's Franklin Large Igneous Province, which is over 2 million km^2 in area.[15]

^{87}Sr is a radiogenic daughter isotope of ^{87}Rb and is found in silicate rocks such as granite, which are a significant part of continental crust. The abundance of radiogenic ^{87}Sr relative to 'common' ^{86}Sr in a sample of sediment is related to the amount of sediment that originated from the erosion of continental crust. Lowered ^{87}Sr/^{86}Sr values indicate hydrothermal and oceanic sources. In north-west Canada, a low ^{87}Sr/^{86}Sr value in early Neoproterozoic strata (ca. 830 Ma) has been correlated with a large input of juvenile crust and the Pan-African event.[16] The Pan-African event relates to massive rifting on the Cordilleran and Appalachian margins of North America, as well as immense continental erosion and enormous water flows.[17] In north-west Canada, breaking open of the crust enabled extensive volcanism, which intruded as far as the top of the Mackenzie Mountains Supergroup, where it formed pillow basalt lavas[8] (figure 2).

The Little Dal Group (at the top of the Mackenzie Mountains Supergroup—figure 2) is inferred to be the highest pre-Flood formation in the Mackenzie Mountains (figure 1).

The basalt which intruded the Little Dal Group (figure 2) is inferred to have formed as part of an ongoing extensional regime while the early Flood year fountains were active. Extension and intracratonic basin deposition (Stage 1 of figure 2) is thought to have occurred contemporaneously with the intrusion of the Franklin and Gunbarrel large igneous province dike swarms of northern Canada.[10]

The Coates Lake Group (the lowest section within the Windermere Supergroup—figure 2) is inferred to have been deposited on top of the Little Dal Group at the very beginning of the Flood year. The sandstone and siltstone-rich unit may have formed from sediments eroded from the land by the massive rainfall. A layer of sulfate[18] within the Coates Lake Group formed when the heat from magma, welling up because of the igneous activity concurrent with the fountains erupting, led to $CaSO_4$ precipitating from the waters. Along with the magma came hydrothermal fluids rich in CO_2. Widespread and prolonged rain and fountains pouring forth (Genesis 7:11–12) caused enormous runoff. Dead organisms and other nutrients carried in the runoff provided food for microbes, which then helped convert the CO_2 to carbonates (figure 2, Stage 2). The laminated, stromatolitic nature of the carbonate layer at the top of the Coates Lake Group supports this interpretation of its formation.[19,20]

The Coates Lake Group likely represents deposition in embayments of a rift system.[9] It hosts significant strata-bound copper deposits in a series of half-grabens, which we suggest are related to the first stage of the supercontinent breakup.[21] Chloride brines may have leached copper from the underlying Little Dal Basalt, and then passed through reducing sulfate-bearing strata of the Coates Lake Group, which triggered the precipitation of copper sulfides.[21] This hypothesis is supported by the fetid, black carbonates of the Copper Cap Formation, which is the top part of the Coates Lake Group.[8.] The coarse-grained limestones have abundant sparry calcite cement with δC^{13} values near zero. These δC^{13} values suggest that the source of the sparry calcite cement is at least in part from CO_2 produced by methane fermentation of organic material in the substrata.[22] The reducing nature of these carbonates could have enabled the precipitation of the copper sulfide.

Enormous rainfall impacted the North American continent at this stage, causing increased erosion and the mass-flow deposition of coarser sediments, forming diamictite along with sandstone, siltstone, and mudstone (figure 2, Stage 2). These sediments characterize the Rapitan through Icebrook formations of figure 2. The Rapitan and Icebrook formations have respectively been correlated worldwide with the supposedly 'glacial' Sturtian and Marinoan strata.[23] The finer-grained shale, sandstone, siltstone, and limestone of the Twitya Formation and the Keele Formation, which overlay the diamictite of the Rapitan, suggest a rising sea level.

The basal Twitya Formation has a cap carbonate overlying the Rapitan Group (figure 2).[18] $\delta^{13}C$ values suggest somewhat higher input of inorganic carbon to the carbonates of the Keele and Ravensthroat formations compared to the carbonate in the Coates Lake Group. This indicates a fresh input of inorganic carbon from volcanic hydrothermal fluids containing carbon dioxide, which led to oversaturation of carbonate and precipitation of calcite and aragonite, some of which later underwent diagenic dolomitization.[24,25] However, the still increasing $^{87}Sr/^{86}Sr$ ratio indicates a significant amount of this carbon may be from continental carbonates that were eroded into the basin as well. It has been proposed that some cap carbonates formed both by microbially mediated precipitation during algal blooms under low salinity conditions and by direct precipitation of aragonite unto the seafloor.[25] The presence of flakestone provides additional evidence for extensive calcium carbonate precipitation.

Stage 2

A. Enormously powerful and destructive continental erosion

The Noahic rain event (Genesis 7:12) was the greatest rain event ever recorded in the history of the earth. Erosion was consequently immense and powerful enough to erode and peneplane hard crystalline basement rocks around the globe and wear mountains down.[6,17] The modern-day canyon formed in the spillway of California's Oroville Dam demonstrates that water is powerful enough to rapidly erode even hard crystalline rock.[26] We infer an enormous erosion of land associated with the early Flood year's rain.[5]

The significant Neoproterozoic $^{87}Sr/^{86}Sr$ isotope ratio increase as reported by Peters and Gaines[1] and reproduced in figure 3 is consistent with enormous erosion of notably radiogenic continental crust[1,5,6,24,27,28] during the Pan-African event.[29] The 'radiometric timespan' for this increase in $^{87}Sr/^{86}Sr$ ratio is approximately 0.4 Gyr (between 0.9 Ga and 0.5 Ga, i.e. early Neoproterozoic to mid-Cambrian—figure 3), but in the biblical framework the actual time elapsed would have been of the order of weeks to months. This 'radiometric timespan' likely represents the time from the initiation of Noah's Flood (associated with fountains hydrothermal activity) and massive continental erosion caused by rain, to a time of greater oceanic influence with accumulation of sediments on the continents as the Sauk sequence began to be deposited.[5,17] $^{87}Sr/^{86}Sr$ ratios in Cambrian sedimentary carbonates are the highest of Phanerozoic strata.[30,31] High crustal erosion rates have been inferred from Cambrian $^{87}Sr/^{86}Sr$ values in north-west Canada.[16] The large supplies of clastic sediments that flooded into basins imply high rates of erosion of the basin hinterlands, which in turn can explain the progressive rise in $^{87}Sr/^{86}Sr$ (figure 3).

Detritus resulting from continental erosion was entrained in flowing water, which produced Neoproterozoic sedimentary cover sequences.[17] This included thick sedimentary successions found in North America's Cordilleran region. Zircon grains of Grenvillian age (1.0–0.9 Ga) were recovered from lower Neoproterozoic sedimentary basins in north-western Canada, more than 3,000 km away from the nearest source in the Grenville Province on the other side of the continent.[11]

The pre-Flood earth and its people were destroyed during the Flood year (Genesis 6:13) in the sense of its topography and people being totally wiped away (Matthew 24:39). This drastic transformation began with an enormous erosional event from the early Flood year's prolonged and globally extensive rain. Early in Noah's Flood year, even high mountains were eroded down and peneplaned. Today's Grenville, Mazatzal, and Yavapai provinces in south-eastern North America are considered to be examples of the roots of eroded mountains.[6,32]

B. Cryogenian mass flows

Enormous torrential rain is inferred to be responsible for initial massive subaerial sheet erosion of the continental landmasses. This was followed by huge submarine mass flows, depositing immense volumes of sediments, as the Flood advanced.[17] In contrast to lower Neoproterozoic sheet

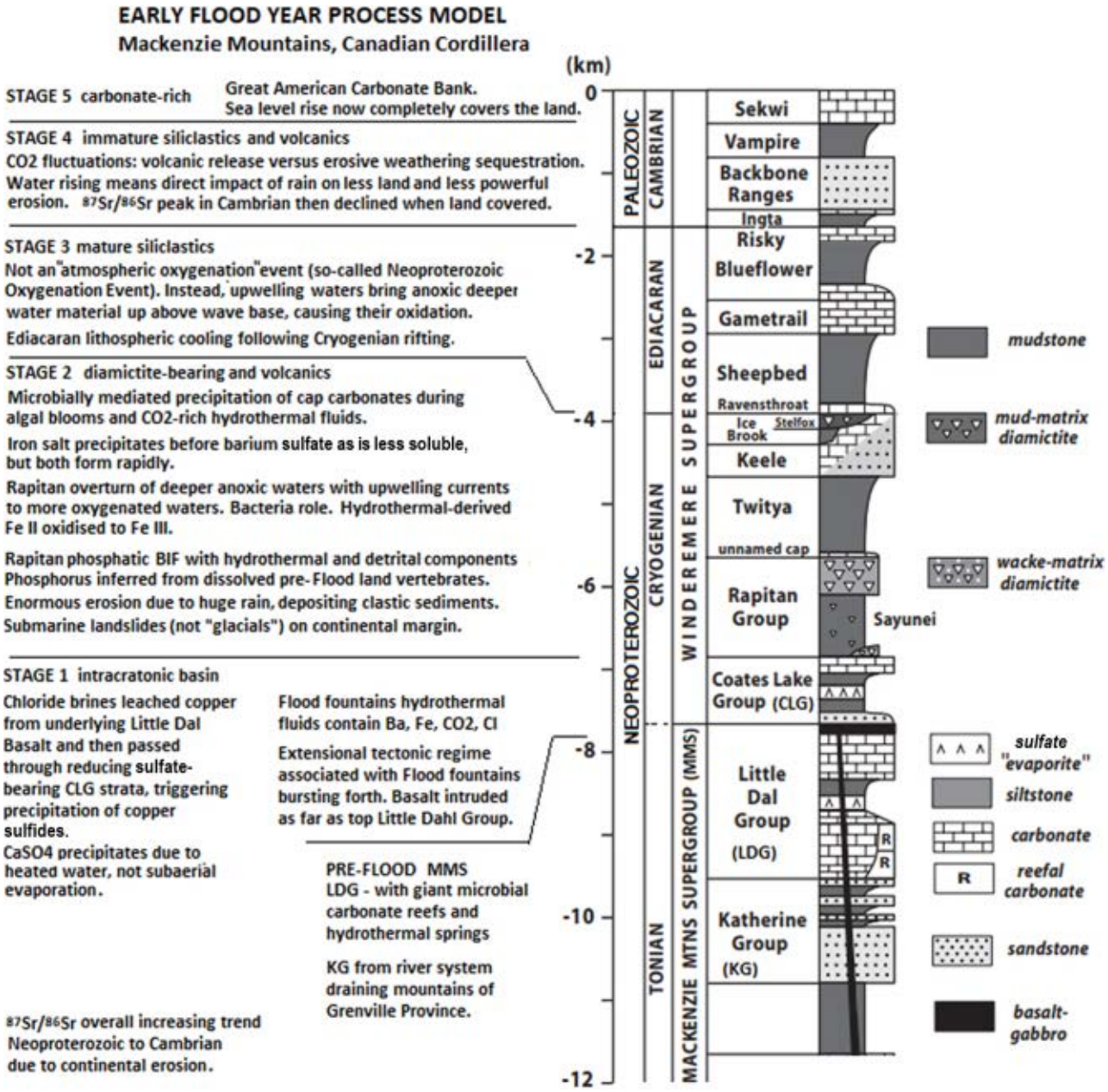

Figure 2. Composite stratigraphic section of Neoproterozoic to Cambrian strata in the Mackenzie Mountains, Canadian Cordillera (section based on Hoffman and Halverson;[8] Stages in the North American Cordilleran margin from Yonkee *et al.*[10]), together with an interpreted early Flood year process model.

sandstones, mid-Neoproterozoic (Cryogenian) sequences contain poorly sorted diamictites, so-called 'glacial' deposits,[14] especially on continental margins such as North America's Cordilleran.[33–35] These 'glacials' are instead considered to represent submarine landslide deposits[33–35] along active tectonic zones as the marine transgression of the Flood year progressed. Cryogenian deposits are mainly poorly sorted immature clastic sediments, with lesser volcanic rocks.

Cryogenian 'glacials' have a close association with sedimentary rocks formed in warm climates.[36] Warm, not cold conditions have been interpreted from associated kaolinite, diaspore, redbeds, dolomite, and limestone with phytolites,[37] as well as abundant carbonates with stromatolites and carbonate ooids.[38] Flakestone, a very distinctive fine-grained carbonate facies with its characteristic broken-up clasts, is an indicator of the action of stormy seas[39] and not an ice-covered sea. Structures interpreted as giant wave ripples (generated by sea surface waves) have been observed in cap carbonate rocks from the Mackenzie Mountains, as well as Australia, Brazil, Namibia, and Svalbard.[40] Waves would not have been

possible in an ice-covered ocean. The ubiquitous association of Neoproterozoic iron formations with thick successions containing numerous levels of rounded dropstones in Canada, Australia, Brazil, and Namibia indicates that mixing across a redoxcline occurred repeatedly during a sustained interval of energetic hydrological cycling, which is incompatible with a globally static ice cover.[25] We regard the Cryogenian Snowball Earth hypothesis as seriously flawed.

Transfer of atmospheric carbon dioxide to the ocean during rifting would enable rapid precipitation of calcium carbonate in warm surface waters, producing the cap carbonate rocks over Cryogenian diamictites which are observed globally.[25] Carbon dioxide build-up from active Flood fountains is believed to have contributed to the rapid precipitation of calcium carbonate discussed earlier.

Massive erosion and deposition due to early Flood year rain is inferred to have rapidly laid down Cryogenian strata. Submarine landslides are indicated by diamictites in the Rapitan Group and Ice Brook Formation. The Rapitan Group (figure 2) consists of diamictite, debris flow deposits, turbidites, siltstone, shale, sandstone (including arkosic sandstone), and volcanics, as well as banded iron formation.[17,41–43] Rapitan iron formations are found in extensional grabens that are associated with the initial breakup of the supercontinent, and are commonly found in association with mafic volcanics. Geochemical data indicates that Rapitan iron formations resulted from mixing between hydrothermal and detrital components, while rare earth element data indicates substantial interaction with seawater.[43]

Overlying the Rapitan Group is more Cryogenian strata, including shallower-water carbonate and siliciclastic strata of the Keele Formation, and the "glacial-related" Ice Brook Formation (figure 2).[21] The Ice Brook Formation has 'hotel-size' megabreccia (figure 2). These so-called 'glacials' may represent a second phase of mass flows early in Noah's Flood year.

The geochemistry of cap carbonates around the world carries a strong hydrothermal signal.[36] Consistent with this, Canadian Neoproterozoic diamictites are marked by negative $\delta^{13}C$ carbonate and correspondingly depleted $\delta^{13}C$ organic and lower $^{87}Sr/^{86}Sr$.[44] Dissolved CO_2 from hydrothermal fluids and volcanic activity would have provided a significant source of inorganic carbon, overshadowing even the effect of massive burial of organic carbon that was occurring throughout the Flood year. The $^{87}Sr/^{86}Sr$ ratio of hydrothermal fluid is lower than that of seawater and continental crust.[45,46] There is an overall Neoproterozoic to Cambrian trend of rising $^{87}Sr/^{86}Sr$ values due to enormous continental erosion (figure 3). However, at times the hydrothermal input caused some dips in the overall trend of increasing $^{87}Sr/^{86}Sr$ values for Neoproterozoic strata.

C. Cryogenian barium, iron, and phosphorus occurrence

The most specific and typical feature of Cryogenian strata globally is the occurrence of so-called 'glaciogene' rocks from two stratigraphic levels. The upper or Marinoan 'glacial' is usually overlain by sediments with a higher concentration of barium. In the Mackenzie Mountains example (figure 1), Ravensthroat dolostone caps the Ice Brook Formation (figure 2) and contains a layer of $BaSO_4$.[18] The lower or Sturtian 'glacial' (such as the Rapitan in figure 2) is commonly associated with sheet deposits of iron ores and basic volcanics.[44]

This appearance of a barium layer several levels above an iron formation is common.[44] We believe this indicates that all the Cryogenian sedimentary layers (between the iron and the barium) must have been deposited rapidly. Hydrothermal fluids characteristically contain iron, barium, and sulfide. If these mixed with seawater above wave base, atmospheric oxygen could oxidize iron and sulfide. Iron oxide deposition in the form of hematite in both Sturtian and Marinoan strata implies a build-up of ferrous (Fe^{2+}) iron in seawater and subsequent mixing of deeper, suboxic water with shallower, more oxidizing water.[25]

Fe_2O_3 is significantly less soluble than $BaSO_4$. However, both are highly insoluble and would be expected to precipitate from the water almost as quickly as they formed.[4,47] The presence of the iron oxides stratigraphically beneath the barium sulfate suggests bacterial action increased the rate of Fe oxidation. The oxidation rate of both Fe(II) and sulfide is variable based on pH and bacterial action.[48,49] Despite the lower solubility of Fe_2O_3, if the $BaSO_4$ formed first it would precipitate first. In this specific environment, the presence of Fe(III) oxides below $BaSO_4$ indicates that the oxidation of the iron was concurrent with or preceded the oxidation of the sulfide, suggesting bacterial action may have encouraged the conversion of Fe(II) to Fe(III). However, it is unlikely that the sulfate took significantly longer to form than the iron oxides. This suggests that the layers between the Rapitan and Ravensthroat were deposited very quickly.

Venting of hot fluids into cold neutral seawater causes rapid quenching and supersaturation, enabling the immediate precipitation of colloidal particles of ferrous hydroxide and hydrous ferrous silicate. The episodic character and rapid deposition of turbidity and density currents, lasting a few hours to days, is in direct contrast to the slow deposition of annual micro-laminations over millions of years inferred by earlier models for the origin of banded iron formations.[50]

During and immediately after the older, Sturtian 'glacial', the deeper parts of the ocean are inferred to be anoxic and with sufficient ferrous iron to sequester very large amounts of sulfur derived from bacterial reduction of sulfate. A huge shift in the sulfur isotopic composition was global, and this is inferred to have been accompanied by the reduction of as much as half the sulfate in the anoxic parts of the oceans.[44]

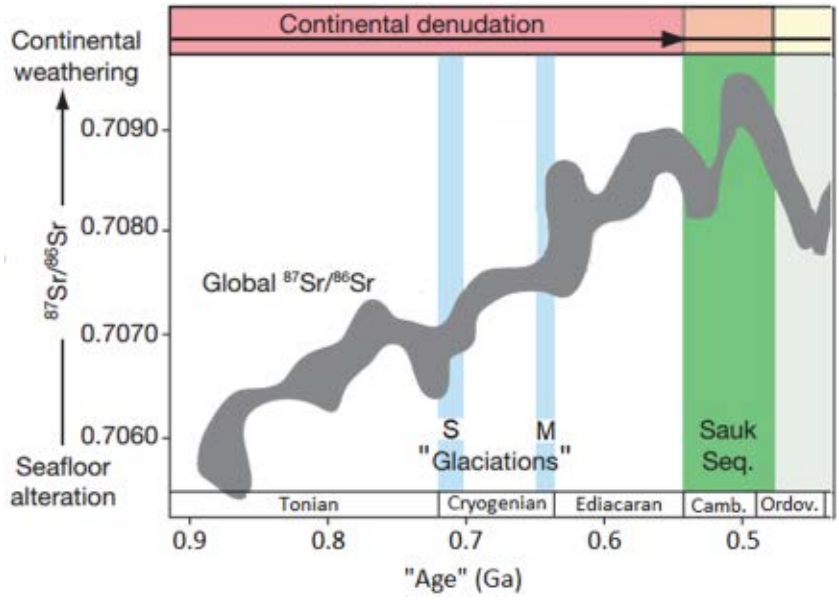

Figure 3. Summary of major geochemical and sedimentary patterns derived from Neoproterozoic to Ordovician strata. There is a shift from widespread continental denudation to widespread sedimentation on the continents (after Peters and Gaines[1]). We infer that:

- The observed increase in the Neoproterozoic strontium isotope ratio $^{87}Sr/^{86}Sr$ can be explained by accelerated rates of denudation due to the impact of the early Flood's rain on the supercontinent and to associated Pan-African event tectonism. The Sturtian (S) and Marinoan (M) supposed 'glaciations' are instead times of massive mass flows due to enormous runoff caused by the colossal rain of the early Flood year.[5,6,17]
- The subsequent decline in $^{87}Sr/^{86}Sr$ ratio in post-Cambrian strata is associated with the first continental-scale marine transgression of the Phanerozoic.[1] The supercontinent was covered with ocean so that the Flood's rain no longer had a direct impact on the land.[5,6,17]

A pouring out of volcanics and associated hydrothermally formed banded iron formations in the Neoproterozoic occurred catastrophically in the early Flood year. The main iron oxide mineral in Rapitan-type BIF is hematite (Fe_2O_3) and this may have appeared blood-coloured.[17,37,51]

The rift-related Rapitan Group (figure 2) hosts billions of tonnes of phosphatic stratiform iron formations[21] and associated diamictite. Rapitan Group iron formation, in common with other Cryogenian iron formations, has much higher phosphate contents than Paleoproterozoic and Archean iron formations.[8] This indicates unusually high dissolved phosphate concentrations and is related to high rates of primary productivity and organic carbon burial.[52]

The greatest global phosphogenic episode in geologic history occurred in Late Precambrian and Cambrian time.[53] It is noteworthy that all continents except Antarctica, to date, are known to have Precambrian-Cambrian transition sedimentary phosphate. These phosphorite deposits are generally found stratigraphically above Cryogenian diamictites, as well as generally below shelly fossils.[37] Precambrian-Cambrian transition phosphorite is associated with catastrophic ocean water mixing (deep anoxic and shallow oxic oceanic waters), as inferred from sulfur isotopes.[54,55] Upwelling of hydrogen sulfide-rich deep ocean water to become surface waters at the Precambrian-Cambrian transition is indicated by the basal Cambrian black shale molybdenum isotope signal.[56] Upwelling currents are inferred to have supplied phosphate-rich waters to continental shelves where phosphorites were deposited around the world.[39] The very active Flood fountains of the great deep would have caused catastrophic mixing of deep and shallow waters.[27,57]

Stage 3: Ediacaran: oxidation/reduction

It has been claimed that there was a rise in atmospheric oxygen in the Ediacaran (late Neoproterozoic), and that this was related to tectonism.[58] This inferred episode of increased atmospheric oxygen is called in the secular literature the "Neoproterozoic Oxygenation Event" (NOE).[17] However, in a YEC model of Earth history, the atmosphere already had to have oxygen levels comparable to modern times since the earth was full of human and animal life.

We do not believe the so-called NOE interval represents a massive increase in atmospheric oxygen. Rather, the increase in oxidized species in the stratigraphic record may simply indicate the movement of elements in a reduced state (such as S^{-2}, Fe^{2+}, and CH_4), from deeper water to above wave base where they underwent oxidation by atmospheric oxygen. The very active Flood fountains of the great deep could have caused catastrophic mixing of deep and shallow waters.[27] Across the globe, it is likely that anoxic seafloor sediment was brought to the surface while near-surface material was suddenly buried. We infer that the resulting near surface oxidation of reduced sediments was the source of the supposed NOE.

Simultaneously, buried organic carbon would have undergone decay, depleting waters of oxygen and creating localized reducing conditions in some areas and at some time periods. Careful study of the redox proxies used to support the NOE, such as $\delta^{82/76}Se$ values,[59] redox-sensitive element enrichment and sulfur isotope ratios,[60] cerium-anomaly values,[61] and $\delta^{238}U$[62] all reveal just such a pattern. Rather than one dramatic and steady oxygenation event, the evidence shows multiple cycles of both oxidation and reduction, with a general pattern of oxygenated surface waters overlaying anoxic waters characterized by organic decay.[60] This pattern is consistent with trends in $\delta^{13}C$ for these sediments.[62] Rather than a single

oxygenation event, the Neoproterozoic waters were characterized by a complex and fluctuating redox chemistry, while the atmosphere maintained a relatively high oxygen content, similar to today.

Stage 3 (Ediacaran) (figure 2) is considered to represent lithospheric cooling following Cryogenian rifting.[10] Ediacaran strata in the Mackenzie Mountains include shale and turbidites of the Sheepbed Formation, carbonate strata of the Gametrail Formation, thick terrigenous, clastic strata of the Blueflower Formation, and carbonate dominated rocks of the Risky Formation.[21] Based on sedimentary facies, these Ediacaran formations are thought to have formed in marine environments with water depths ranging from deep (continental-slope) to shallow (areas of wave action).[9]

Mass mortality and a sudden decrease in biological productivity prior to the 'Cambrian explosion' (the lowermost appearance of shelly fossils in the stratigraphic record) has been inferred from a negative $\delta^{13}C$ global geochemical anomaly in carbonate-containing black shale at the Precambrian-Cambrian transition. Kimura and Watanabe[63] claimed that this corresponds to the widespread development of an oxygen-deficient (anoxic) shallow marine environment—a "Strangelove ocean".[64] We suggest that this relates to the consumption of oxygen in shallow waters due to the presence of dissolved organic material undergoing decomposition. This dissolved organic material has been inferred to include that derived from pre-Flood animals and some shelly invertebrates.[27] Vertebrate decomposition uses oxygen from the surroundings,[65] creating anoxic conditions.

Stage 4: Immature siliclastics and volcanics

This stage is characterised by continuing erosion as evident by the increasing $^{87}Sr/^{86}Sr$ ratio trend for North America which reached a peak within Cambrian strata[1] (figure 3). As mentioned in Stage 1, the abundance of radiogenic ^{87}Sr relative to 'common' ^{86}Sr in a sample of sediment is related to the amount of sediment that originated from erosion of continental crust as opposed to that originating from the ocean. In other words, the strontium isotope ratio $^{87}Sr/^{86}Sr$ is linked to runoff caused by erosion. This runoff in turn is related to the amount of rainfall and to tectonism. At times of lower rainfall there is less runoff, and conversely with more rainfall more runoff occurs.[66] "Tectonic setting is the principal controlling factor of lithology, chemistry, and preservation of sediment accumulations in their depocenters, the sedimentary basins."[67] In summary, the greater the topographic relief due to tectonism, and with more rain, the more the runoff and greater volume and thickness of sediment deposited.

In the Mackenzie Mountains the Neoproterozoic strata is over 10 km thick (figure 2). This huge thickness of strata is consistent with the effects of Pan-African event break-up tectonism, active fountains of the great deep and enormous rain in the early Flood year, commencing with Stage 1. Water and entrained detritus flowed downward towards the continental margins where there is now thick Neoproterozoic strata. Sea level in the pre-Flood seas would have risen at the same time as the adjacent land was being massively eroded, until eventually the whole globe was covered with water and the rain no longer directly impacted the land. Sea level rise indicated by North America's Sauk Megasequence is inferred to follow the initial break-up of the supercontinent.[68]

The continuity of the basal Sauk sandstone layer across North America is a testimony to the extent and uniformity of the first great marine transgression of the Phanerozoic.[69] In the Mackenzie Mountains of Cordilleran Canada this sandstone is represented by the Backbone Ranges Formation[9] (figure 2). Lower Cambrian strata correspond to the onset of the first major Phanerozoic marine transgression preserved extensively in North America at the base of the transgressive Sauk Megasequence, which culminated in the Great American Carbonate Bank.[70]

Marine transgressive deposits can be recognised through an upward deepening of facies.[71] In addition to North America, evidence of sea level rise is provided by a universal fining upward sequence that has been observed in other Cambrian and Lower Ordovician (Sauk Megasequence) strata around the world including Greenland, UK, Russia, Australia, Bolivia, and Ghana.[72] A classic fining upward succession occurs in Grand Canyon Cambrian strata (Tapeats Sandstone then Bright Angel Shale). Similarly, in Stage 4 of the Cambrian of the Mackenzie Mountains, the Backbone Ranges Formation sandstone is succeeded by the Vampire Formation mudstone (figure 2). "Global or worldwide marine transgression" is the descriptor in the secular literature.[55] This is another way of saying global flooding!

Fluctuations in carbon dioxide levels during Stage 4 are considered to be related to the fluctuating opposing influences of volcanic release[73] versus consumption with the weathering process.[1] It has been inferred that, during Stage 4, rifting of the supercontinent and associated volcanism led to separation and transition to drift with the opening of an ocean basin in the west of Cordilleran North America.[10]

Stage 5: Early Paleozoic sea and carbonates

Subsidence histories of passive margins are a key indicator of worldwide continental extension and then ocean formation beginning at 0.6 Ga.[13] Cambrian (through Devonian) strata of the Mackenzie Mountains were deposited on Neoproterozoic strata in a developing passive margin which underwent thermal subsidence.[10] An expansive Paleozoic siliciclastic-carbonate passive margin was established,[9] beginning with Stages 4 and 5 (figure 2).

We acknowledge and commend the great amount of work that fellow creationists Tim Clarey and co-workers have

done in mapping the thickness and extent of megasequences on several continents.[74] This data compilation was used to infer a sea level curve based on the assertion that the lateral extent, volume, and thickness of the megasequences relates to the height of sea level.[75] For instance, they inferred that the lesser lateral extent and volume of sediment in the Sauk Megasequence indicates minimal flooding.[76] However, these assertions regarding height of sea level and amount of flooding are refuted by numerous lines of evidence. $^{87}Sr/^{86}Sr$ ratio and sedimentary thickness curves correlate[77] because both curves are a function of runoff. As mentioned in Stage 4, runoff and therefore the thickness and volume of sediment, is related to tectonism and rainfall.

The great thickness of Neoproterozoic strata (over 10 km in Stages 1–3) (figure 2) due to rain and powerful tectonism was followed by much thinner Cambrian strata (Stages 4 and 5) (figure 2). During marine transgression, such as in the Cambrian, the coastline moved landwards and the marine area enlarged. This is accompanied by a *reduced* sediment influx to the basin.[71] Water rising in Stage 4 meant less area with direct impact by rain and so less sediment influx and less powerful erosion. Times of sea level rise over land are marked by an excess of carbonates over siliclastics.[66] This can be seen in Stage 5 with the Great American Carbonate Bank.

Major oil companies find sea level curves to be invaluable in petroleum exploration since they provide useful models to help predict the location of reservoir rocks and petroleum source rocks. Researchers at Exxon were among the first to develop global sea level curves using seismic stratigraphy, based on oil exploration seismic and well data from around the world.[78] The Exxon sea level curve rises in the Cambrian to a peak at the end Cambrian. Subsequently, others refined Exxon's curve and interpreted global sea level to have risen in the Cambrian to an Ordovician peak.[79,80]

Haq and Shutter used reference geological sections from North America, Australia, northern and southern Africa, north-western Europe, and China to develop their curve for the Paleozoic. This augmented earlier results from subsurface data and the stratigraphic interpretation method of Exxon. Quantitative data from paleontology demonstrated increased diversity of plankton and pelagic organisms with higher sea level.[81] The global Cambrian to Ordovician increase in marine invertebrate genera has been related to increased habitat area as the rising sea level transgressed the land.[66,82] During sea level rise and maximum flooding of continental shelves, increased biological productivity, combined with greater preservational potential for organic matter in the expanded and deeper lower oxygen zone, make such sediments most likely locations for petroleum source rocks.[81] In addition to seismic stratigraphy, Hallam used additional techniques such as paleogeographic mapping, occurrence of depth-related invertebrate and algal groups, glauconite concentration and facies correlation to develop sea level curves for the Phanerozoic.[79]

Drowning of cratons has been inferred from lithofacies changes in uppermost Proterozoic and Cambrian strata around the world. Peritidal carbonate platforms were drowned, to be followed in places by phosphorites and then black shales which form in deeper water.[83] This drowning of cratons has been inferred to correlate with the time Noah's Ark rose and floated on the waters.[27]

Consistent with the above-discussed independent lines of evidence (seismic stratigraphy, fossils, and sedimentary facies), the decline in $^{87}Sr/^{86}Sr$ ratio after the peak in Cambrian strata[1] (figure 3) is inferred to be due to ocean formation,[13] such that the enormous rain of Noah's Flood no longer directly impacted the land.[5,17] In other words, by Stage 5 rising water in the early Flood year covered the land.

Deposition of the Sauk Megasequence of north-western Canada occurred along a complex segment of the rifted western margin of North America.[84] The Great American Carbonate Bank comprises the carbonates (and related siliciclastics) of the Sauk Megasequence, which were deposited on and around the North American continent during Cambrian through earliest Middle Ordovician, forming one of the largest carbonate-dominated platforms of the Phanerozoic.[85] Although the term 'Great American Carbonate Bank' is understood to have originally just been used for the North American continent, the term has also been used elsewhere, such as in western South America,[86] as well as Scotland and Greenland.[87] Cambrian carbonate-rich strata, such as the Sekwi Formation of the Mackenzie Mountains (figure 2), accumulated in an extensive shallow epicontinental sea as siliciclastic sources were covered during the Sauk marine transgression.[10]

While carbonates were forming throughout the Flood, precipitation of carbonate sediments reached a peak in the Cambrian-Lower Ordovician strata of the Sauk sequence of North America.[88] Petrographic textures (displasive growth of calcite crystals within the claystone matrix) and depleted $\delta^{13}C$ values provide evidence of rapid direct precipitation of carbonate at the sediment-water interface.[1] The 'Cambrian explosion' of organisms with carbonate skeletons and the proliferation of bioturbating organisms are coincident with the onset of a carbon cycle with isotopic fluctuations damped in both frequency and amplitude.[44]

The Cambrian-Lower Ordovician peak in carbonate formation may possibly have been enhanced by input of fresh rainwater along with high concentrations of carbon dioxide. Although we infer that Flood waters had completely covered the land, continuing rain may have contributed a significant amount of freshwater, which is more favourable for carbonate precipitation than seawater. Simultaneously, CO_2 input may have peaked as the Cambrian has been inferred to have the highest modelled atmospheric carbon dioxide concentrations of the Phanerozoic.[89]

Conclusions

Geochemical processes played a significant role early in Noah's Flood year. We have proposed a time sequence of early Noah's Flood year including various items of evidence, with an emphasis on geochemistry of North America. Early Flood year processes discussed include fountains bursting forth, enormous rain, and the timing of sea level rise.

The Neoproterozoic to Cambrian stratigraphy of the Mackenzie Mountains of north-west Canada is used as an example (figure 1). Early Flood year geological products are inferred to include volcanics, huge continental erosion, sheet sandstones, mass flows, banded iron formations with high phosphate content, nutrients, and marine invertebrate diversity.

Backed up by evidence, we infer key differences to current common secular views of Neoproterozoic geological history:

- So-called 'evaporites' in Little Dal Group and Coates Lake Group formed by hydrothermal means, rather than by sub-aerial evaporation.
- Cryogenian diamictites formed by mass flows rather than by 'glaciation' and a 'Snowball Earth'.
- Neoproterozoic oxidation of sediments due to vigorous upwelling and mixing of suboxic sediments associated with energetic Flood fountains, rather than the 'Neoproterozoic Oxygenation' of the atmosphere.
- Deep-time is unnecessary and unrealistic for geochemical reactions (such as formation of BIF and copper sulfide orebodies), particularly under hydrothermal conditions.

Key inferences in time order:

1. The Mackenzie Mountains Supergroup represents pre-Flood deposition in a large epicratonic basin. Katherine Group quartz arenite was in part delivered by a continent-crossing early Neoproterozoic river system draining the mountains in the south-east of North America. Sulfate 'evaporites' of the Little Dal Group indicate the action of hydrothermal springs in a hydrothermal biome on the pre-Flood continental shelf.
2. The bursting forth of Flood fountains is indicated by extensional tectonism and associated large igneous province activity and intrusives into the Mackenzie Mountains Group.
3. Early Flood year's enormous rain caused huge continental erosion, consistent with the Sr ratio trend upwards from the Neoproterozoic to Cambrian. This erosion was powerful enough to wear down crystalline basement rocks.
4. Supposed 'glacials' in the Cryogenian strata (Rapitan Group and Ice Brook Formation) are considered to have formed as mass flow deposits associated with downslope water movement in early Noahic Flood times.
5. Rapitan phosphatic BIF formed hydrothermally in association with volcanic activity.
6. Carbonate-rich marine Cambrian strata formed in North America and some other continents as the sea transgressed the land.
7. Sr ratio decreased post-Cambrian as the land was covered by water and the rain was not directly impacting the land.
8. Cambrian to Ordovician increasing sea level and increase in marine invertebrate diversity.

A possible application for further investigation is to use geochemistry to help distinguish other phases of the Flood event year, such as marine regression and drying phases.

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The Jurassic Coast, England and its dry valleys: periglaciation or Noah's Flood?

John D Matthews

The Jurassic Coast, an English World Heritage Site, attracts many geologists trying to understand its distinctive geomorphological features—particularly the numerous dry valleys. While uniformitarian geomorphologists persistently offer periglaciation as their best explanation, they admit that it and all other models are deficient. This paper evaluates a model associated with rapid subterranean uplift, and erosion through fast movement of the associated water. It has the hallmarks of the retreat of the Noachian Flood.

The Jurassic Coast, a World Heritage Site,[1] extends for 155 km across the south-western counties of Devon and Dorset in England (figures 1 and 2). Its varied geology, which (in uniformitarian terms) includes sedimentary rocks from the Triassic to Eocene, attracts a wide range of geologists and oil prospectors. Uniformitarians ascribe the arrangement of the rocks to over 200 million years of slow sedimentation, modest erosion, and gentle uplift.

The landscape is amazing, with numerous dry valleys throughout these counties. Some lie on the coast while others, lying inland, merge into wider river valleys. Under Buckland's[2] influence geologists initially thought that many wide valleys, particularly in Devon around Seaton and Sidmouth (figure 2), were eroded out by the rapid retreat of the Noachian Floodwaters (table 1 provides the geographical locations of all features mentioned herein). In contrast, Lyell wanted to "free the science [of geology] from Moses"[3] and insisted that his uniformitarianism fully explains everything.[4,5] However, he offered no evidence or direct comparison to show that uniformitarianism was a better explanation than a robust biblical scheme. Moreover, he did not discuss dry valleys.

Later, the belief that multiple ice ages had occurred led uniformitarians to suggest that, where glaciation had taken place, subsequent melting of ice sheets or the unlocking of stored water temporarily impounded by ice dams provided intense but short-lived torrents of water which apparently did the work of erosion, leaving behind dry valleys. It has been suggested that even Buckland was later prepared to accept that glacial effects were important agents affecting the landscape.[4,6]

Reid suggested[7] that in areas adjacent to those glaciated, there would probably have been sub-zero temperatures. In consequence, freeze/thaw cycles could have resulted in breaking up of surface rock, which could then have been swept away by meltwater when each cold period relaxed. Repeated occurrences would then leave dry valleys when the most recent Ice Age Stage finally ended.[7] As will be shown below, applying this model to the Jurassic Coast has not really worked. Nevertheless, it is the front-runner of around 20 ideas put forward to explain the dry valleys, judging by the way periglaciation is firmly identified as a feature of the area.[8–11]

First, this paper examines uniformitarian attempts to explain features of the landscape, such as dry valleys being created by periglaciation, and confirms the weaknesses that have already been identified with this explanation. Second, it proposes an explanation for dry valleys on the Jurassic Coast involving rapid uplift and fast movement of water, consistent with the retreat of the Noachian Flood. To achieve this, periglaciation and associated models must first be detailed. This will include reference to the inland dry valleys, which reveals the credulity geomorphologists have for periglacial explanations.

Glaciation and periglaciation in England

The last glacial maximum in England is judged by uniformitarians to have been in the period 116–11.7 ka, and named the 'Devensian' Stage.[12] It only covered about 40–50% of northern England, so the ice sheets were always at least 200 km to the north of the Jurassic Coast. Prior to the Devensian, there was a 'Wolstonian Complex/Stage' (200–300 ka). Even earlier was an 'Anglian' Stage with ice sheets reaching further south than the Devensian and coming within 100 km of the Jurassic Coast. This distance is still too far to have had a direct hydrodynamic-erosional effect on the Jurassic Coast. Water spilt from the melting would have left hallmarks nearer the edges of the ice sheets long before reaching the Coast. However, much is uncertain about the precise boundaries of maximum movement of the ice sheets southwards and their order of encroachments. In particular, the "Anglian is not well-marked by end moraines but by ... thinly scattered erratics".[10] Furthermore, the whole concept of a Wolstonian Complex/Stage is controversial because in the Midlands the Wolstonian sediments are beneath Anglian.

Uniformitarians are clearly uncertain over the timing, extent, and causes of the ice ages in England. Nonetheless,

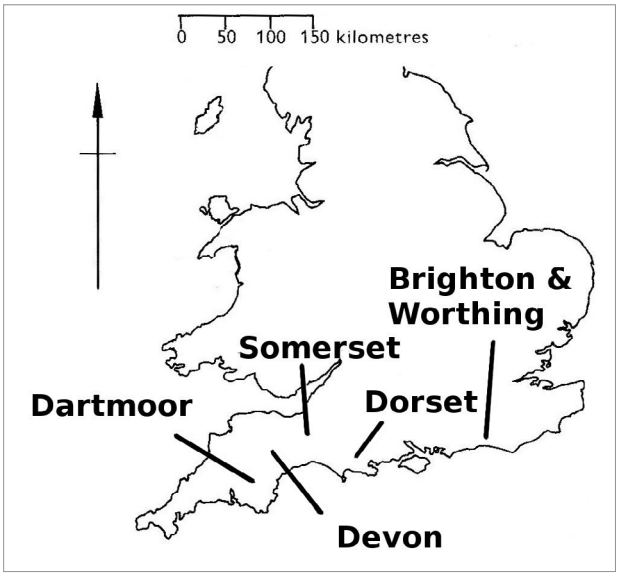

Figure 1. Map of SW England

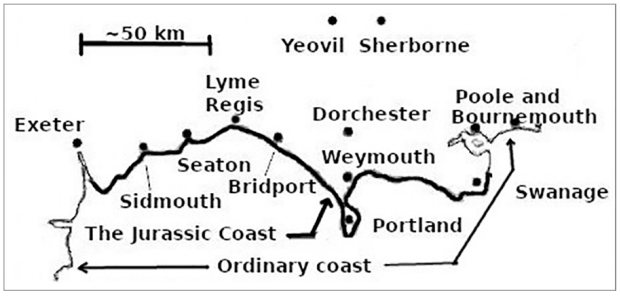

Figure 2. The Jurassic Coast and its towns

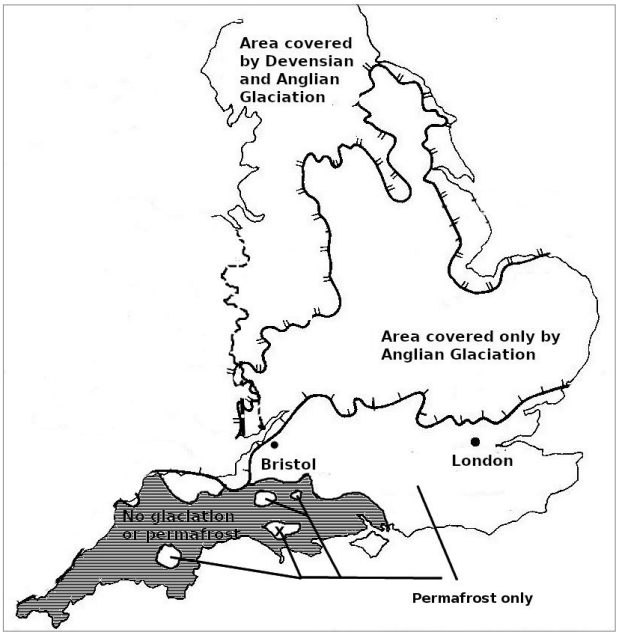

Figure 3. Limits of glaciation and permafrost in England

they generally consider that the region immediately south-west of the extremity of the Anglian ice age was an area of patchy periglaciation[10] (figure 3). For example, periglaciation is considered to be the cause of the inland dry valleys, marked X on figure 3, but there is some equivocation over whether they were formed by a two-stage process.[9] Furthermore, there is a dearth of the normal supporting periglacial features such as involutions and soil patterns in the south-west marked on published maps.[10,12] The south-east of England, which appears to have evidence of permafrost, can be temporarily ignored, and treated in a later study.

The dry valleys

In Dorset alone the number of dry valleys runs into the hundreds. Some are short (500 m apex to mouth), others long (5 km); some meander while others are straight; some are on sandstone while others are on chalk; some end in coastal cliffs; and others merge into larger valleys containing rivers.

Figure 4 shows the classic, Jurassic Coast example of Scratchy Bottom. To date, a wide range of these dry valleys have been extensively reviewed.[8–15] A map of the valleys in the coastal area of Lulworth and Durdle Door is shown in figure 5, with basic details in table 2. The dominant directions seem to be north to south, with a few east-to-west or west-to-east. Four of those valleys end in the cliffs exposing the underlying rock layers. The details in table 2 were obtained from the contours on the ordnance maps supported by the author personally visiting a selection of locations and using GPS equipment to spot-check locations and heights shown on the maps.

Since the dry valleys on the coast all expose their underlying geology, strata, and folding, an integrated picture of events leading to their formation can be proposed. In contrast, only limited trenching has been possible on one inland valley to understand the subsurface geology and regional dips.[9]

Uniformitarian assessment of dry valley mechanisms

Twenty suggestions have been put forward for explaining dry valleys in England and Wales.[8,10] It is reasoned that some dry valleys were produced during periglaciated conditions, and clear references have been made to Dorset's inland dry valleys[9] even though supporting evidence of periglaciation (soil patterns, involutions, etc.) in this part of the south-west is missing.[10,12]

Interestingly, it is also noted that given "the great diversity of dry valley forms and locations, no single explanation will suffice for all types."[10] When it comes to explaining a significant cluster of dry valleys in the Dorset portion of the Jurassic Coast, the latest recommendation is that researchers studying in this region review their suggestions and provide robust explanations.[8]

Table 1. Locations of places mentioned

Place	Feature/s	Ordnance	Long and Lat
Bridport	Coastal town	SY 46-93	W 2/45, N 50/43
Chaldon	Inland village	SY 79-83	W 2/16, N 50/38
Culpepper Dish	Inland sinkhole	SY 815-925	W 2/16, N 50/43
Dorchester	Inland town	SY 60-90	W 2/26, N 50/42
Dungy Head	Coastal feature	SY 815- 98	W 2/15, N 50/37
Durdle Door	Coastal feature	SY 805-802	W 2/16, N 50/37
Lulworth Cove	Coastal feature	SY 825-800	W 2/14, N 50/37
Portesham	Inland town	SY 60-85	W 2/33, N 50/46
Scratchy Bottom	Coastal dry valley	SY 802-804	W 2/16, N 50/37
Seaton	Coastal town	SY 25-90	W 3/04, N 50/42
Sherborne	Inland town	SY 64-17	W 2/30, N 50/56
Sidmouth	Coastal town	SY 12-87	W 3/15, N 50/41
St Oswalds Bay	Coastal bay	SY 812-802	W 2/16, N 50/37
Swanage	Coastal town	SZ 03-79	W 1/57, N 50/36
Weymouth	Coastal town	SY 68-79	W 2/24, N 50/37
Winfrith	Inland Village	SY 80-84	W 2/15, N 50/39
Yeovil	Inland town	SY 56-17	W 2/38, N 50/56

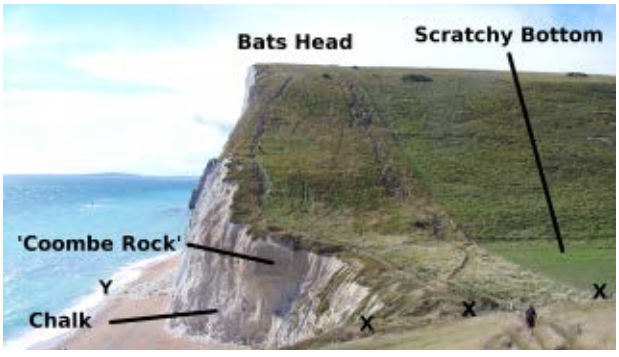

Figure 4. The Scratchy Bottom dry valley

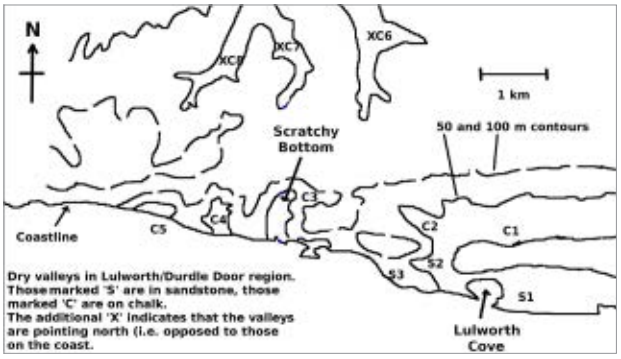

Figure 5. Map of dry valleys

To justify periglacial explanations for at least some valleys, five arguments have been offered by Goudie.[10] They are listed in order with individual comments directly embedded.

1. "Many of the dry valleys are fronted by a fan of debris ('head', coombe rock), which is thought to be frost-shattered debris moved by solifluction."

'Solifluction' refers to the idea that fragments of rock, large and small, can move down slopes of just a few degrees by gravity alone. However, when trying to show that the coombe rock is frost-shattered debris by thermally cycling chalk below the freezing point in a laboratory, a slurry rather than chalk fragments was produced.[16] Moreover, this fails to explain the variability in the debris and its structure (see below for specific examples).

2. "Some dry valleys … contain sarsen blockstreams, the mechanism for the movement of which is probably solifluction."

An example of sarsens (clusters of sandstone blocks) is from the Valley of Stones, near Portesham, Dorset. Figure 6 shows a distant view of some of the stones and a close-up of

Figure 6. The valley of Stones near Portesham, Dorset

a cluster. It is not clear why this feature suggests a periglacial mechanism, which may explain why the word 'probably' was used in the statement.

3. "Some dry valleys have asymmetric slope profiles and cryopediments."

It is argued that the asymmetric profiles are partly explained by the different angles at which the sun's rays impinged on the area. This resulted in different levels of melting and water run-off, producing asymmetric erosion. But there are many valleys that are not asymmetric, oriented in every conceivable direction within small and large areas. The suggestion that this indicates periglaciation is thus flawed. On the cryopediments, the problem of explaining the origin of the broken rock by freeze-thaw cycles[16] rules out Goudie's suggestion, and so the sediments may not be 'cryogenic'.

4. "The rarity of notches in the chalk scarp crests of southern England may be explained by the fact that most dry valleys are of periglacial origin and thus of no great age. Thus retreating escarpments have not had time to behead more than a small number of dip-slope valleys."

The rarity of notches is not *prima facie* evidence for periglaciation. Moreover, 'beheading' is a mechanism used by uniformitarians to explain 'so-called' river capture, but it has a more realistic explanation through a Flood mechanism, e.g. in the English Weald.[17]

Finally, it is noted:

5. "Many of the dry valleys in the Chilterns do not seem to be related very strongly in their direction to the joints in the chalk, maybe because they were fashioned by periglacial torrents working on rock that was impregnated with permafrost."

Based on Reid's model,[7] there is no uniformitarian answer as to where his convenient "torrents", which are needed to move the sediment, came from. And while some dry valleys are almost straight (e.g. the Seven Sisters, near Brighton), there are many valleys which show meanders and even turn at right angles. To that extent, this can only explain a trivial number of valleys, and so adds little to the discussion.

Towards a robust explanation of the coastal dry valleys

As mentioned above, the dry valleys on the Jurassic Coast provide visible information on the underlying geology (i.e. the strata and their disposition). There have also been suites of seismic surveys and the drilling of deep oil wells in the area because of hydrocarbon extraction.[18] While only some information collected has been made public, we can propose

Table 2. Locations of dry valleys reviewed in this study

Valley	Location	Length	Slope	Width at 'mouth'	Stratum
C1	West Lulworth to Cove	2 km	0.03	200 m shared with C2	Chalk
C2	Caravan Park to Cove	2 km	0.05	Shared with C1	Chalk
C3	Scratchy Bottom	1 km	0.01–0.10	300 m	Chalk
C4	Between Swyre Head and Bat's Head	600 m	0.20	400 m	Chalk
C5	'Middle Bottom'	200 m	0.40	600 m	Chalk
S1	Army Ranges	1.5 km	0.05	200 m	Wealden sst
S2	Car Park	1 km	0.15	150 m	Wealden sst
S3	Into St Oswald's Bay	500 m	0.10	100 m	Wealden sst
XC6	Towards Winfrith	2.5 km	0.04	300 m	Chalk
XC7	Chaldon East	2 km	0.05	200 m shared with XC8	Chalk
XC8	Chaldon West	2.5 km	0.04	Shared with XC7	Chalk

the following simplified geological history of the area without adhering to the uniformitarian timescale.

The earlier sediment deposits in the area along the coast from Swanage to Weymouth (about 40 km) were likely originally oriented almost horizontally (figure 7). Extensive folding then took place near what would become the coast (a monocline),[19] resulting in some of the layers being tilted by up to 110° (although only drawn at about 70° in figure 8). Furthermore, some hinge-folding occurred, so that the almost-vertical layers do not follow a single compass direction. Now the Jurassic limestone (labelled JL) is quite hard, but in tilting its brittle nature likely resulted in much cracking and splitting, allowing the broken rock to be subsequently carried away by rapid run-off of water. The Wealden and Lulworth beds (WL) are soft. The chalk (C) is moderately hard, but in the tilting several faults developed, and one relevant to this study is shown hatched with the direction of movement indicated (figure 8).[14]

Could a Flood-type explanation be advanced for these dry valleys? In tandem, the boundaries of the regions that uniformitarians consider having been periglaciated will have to be pushed back. Indeed, the 11 examples used in this study (and many others in the area) suggest that a global flood with rapid retreat of the water is an exclusive and holistic solution. Periglaciation, as a competitor, is irrelevant provided that the following points are satisfied by this alternative model of events:

1. There is a non-periglacial explanation for shattering the chalk before the valleys formed.
2. The catchment areas for rain and snow are so small that they do not provide storage space for the necessary large volumes of water to achieve rapid erosion.
3. The underlying rocks are quite permeable.
4. That current erosional rates at the mouths of these dry valleys suggest a shorter timescale since their formation occurred (i.e. thousands of years ago not millions—conflicting with uniformitarian timescales and consistent with the biblical timescale).

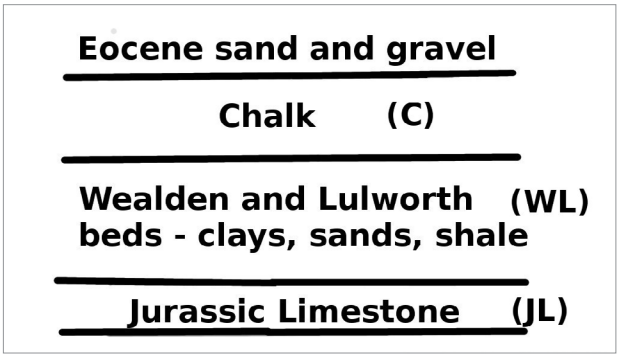

Figure 7. Strata laid out horizontally

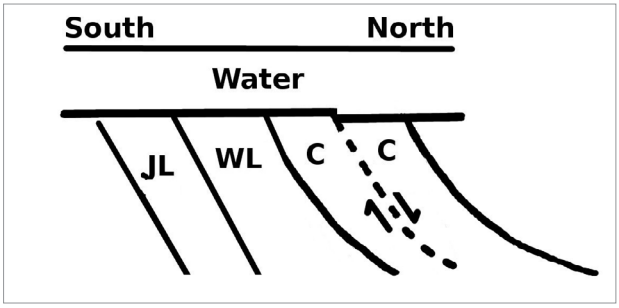

Figure 8. The strata as tilting begins

5. That multiple landform features indicate a short period of rapid erosion (i.e. the 'retreat' taking days not thousands of years, fitting within the one-year biblical timescale of the Flood).[20]

Reasons for an exclusive Flood explanation

These five issues can be addressed in the affirmative as follows:

Shattering the chalk before the valleys formed

At beach level, the chalk is exposed on these coastal dry valleys. It shows a mixture of light to heavy fracturing

Figure 9. Fractures in the chalk with sandstone staining

Figure 10. Coastal Erosion in St Oswalds Bay

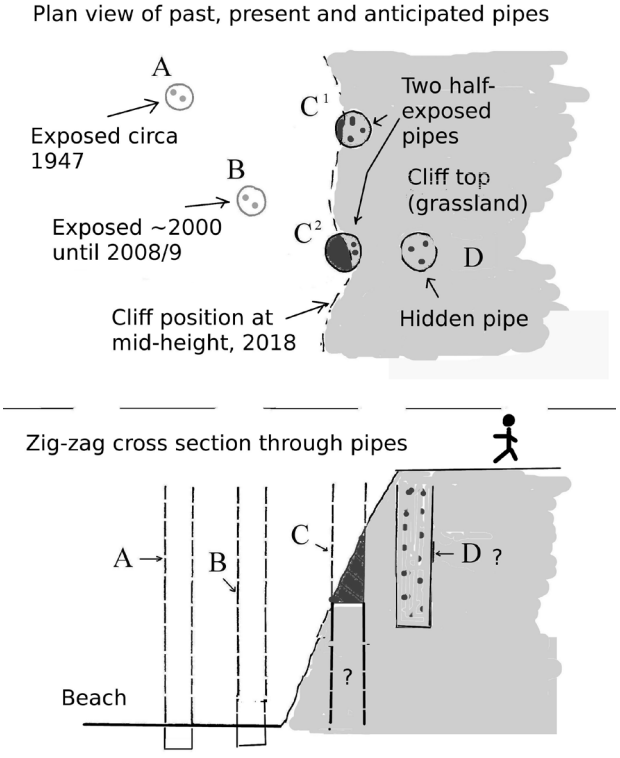

Figure 11. The Red Pipe phenomenon

because of intense tilting and folding (figure 9). The dry valleys on the beach side (C1 to C5) cut through the upturned chalk roughly at right angles. Therefore, they were formed after the chalk had tilted, and thus after the chalk had fractured. Three of the valleys are cut into the Wealden sandstones, which are relatively unconsolidated. So, rocks in the area did not need to be preshattered by periglacial frost. The tilting was responsible for some, and unconsolidated sediments for the others.

At some locations along this stretch of coast, the chalk is not fractured. It is heavily consolidated and seemingly impermeable, judging by the slower coastal retreat (figure 10). Dry valleys are not present there. Furthermore, these consolidated regions would have exerted control on the formation of dry valleys, limiting their east-west development. See the Scratchy Bottom example below.

Minimal catchment areas

Figure 5 shows that there are no catchment areas for rain and snow of any significant size, or even space for ice dams. So, calculations of the amount of ice to be thawed are redundant. There are sets of opposing dry valleys (such as C4 and XC8, C3 and XC7, C2 and XC6), and the area between these opposing valleys is on an anticline. The uplift of the anticline from 200 m below the water level caused water to run both north and south in the 'torrents' desired by Reid[7] and eroding out the dry valleys. The 200 m depth of water suggested by uniformitarians at the end of the 'Cretaceous' period[21] and available to erode the valleys is consistent with a Flood explanation.[22] The Flood likely began to retreat in the 'Upper Cretaceous', though it is not a universal time-marker because of inconsistencies in the geological column.[23]

The valleys were permeable

Since many of the fractures show staining from the 'Eocene' sands and gravels, which originally lay above the chalk (figure 9), there was a 'fracture' permeability. Bulk (or matrix) permeability is even clearer because of a feature known as 'Red Pipes'. The pipes were first described when a huge feature called 'The Red Hole' in St Oswalds Bay was noted.[13] It originally showed in the face of the cliff and extended below beach level, but evidence of it has been lost because the cliff has retreated. Further 'pipes' have since been exposed and removed.[22]

Figure 11 illustrates this mechanism. A number of 'pipes' containing 'Eocene' sands and gravels vertically penetrated the upturned chalk, shown in plan and cross section. The pipes were effectively drainage features. The chalk, while still unconsolidated in places, was still saturated by water during uplift. While the chalk was uplifted above sea-level, and as water left the areas in sheet-form overland, and concentrated channel-flow over the top of the rocks, additional water drained downwards by 'Darcy' flow, carrying with it loose chalk.

Pipe A represents 'The Red Funnel' (~1947) and pipe B the feature in the author's photograph (~2005) marked (*) (figure 12). Evidence of these has since been lost to cliff retreat—the one marked (*) in the winter 2008/9. Pipes C1 and C2 represent pipes that are half exposed at the present. Pipe D is hypothetical at this stage since it has yet to be exposed. Note that there is no surface expression of the 'pipes' because of grass land coverage.

Uniformitarians argue that these 'pipes' were formed by chemical dissolution since rainwater is slightly acidic.[14] The creationist counterchallenge is:

1. It needs more than a few years to chemically remove large quantities of chalk with a very dilute acid. We don't have major amounts of time based on re-assessing radiometric dating[24] or the assessment of time described below in item 4.
2. Erratic pathways are more likely to form than reasonably straight, vertical 'pipes' (as experience of chemically fracturing oil wells in chalk demonstrates) if rainwater is focused in a small area. In addition, if the uniformitarians insist that the folding was slow, then the pipes would not be vertical, but would have curved sections corresponding to the rate at which the tilt progressed.
3. There are many sinkholes in the area, including the famous Culpepper Dish,[14] which are found at higher elevations. So, acidic dissolution of chalk is not a phenomenon in the area. Rather the evidence points to a collapse of soft material.
4. Some of the 'pipes' show rapid entry of the 'Eocene' material as if it had gone down a pre-existing lift shaft. On its journey down, some segregation of fragment sizes occurred (figure 13) consistent with falling through a viscous medium such as water.
5. The flint, originally interspersed in the chalk and immune to attack from dilute acid, should collect at the bottom of a 'pipe'. It is not there.

Recent erosional events

To resolve how recently the events happened, note that the chalk cliff is receding by several centimetres per year at various locations in the bay.[25] The offshore stubs of 'Jurassic' limestone rock are around 200 m away and are submerged at high tide (figure 10, taken at low tide). At some stage in the past, the tilted limestone would have been higher (this is visible in the cliff in the same rock in the distance, Dungy Head, and observable in the cliffs a short distance to the west—from where the photograph was taken—at the Durdle Door Arch). It would therefore have protected the chalk cliff against erosion from the sea and tide. The removal of the top sections was almost certainly coincident with the development of dry valley S3 since it reaches down to beach level. So, the time to erode the chalk to its present position from the stubs of Jurassic limestone is around a few thousand years based on the present rate these cliffs are retreating—perfectly consistent with biblical timescales.

Possible rapid erosion

Evidence for fast formation of the valleys (in a matter of hours) is provided when we consider Lulworth Cove and Scratchy Bottom.

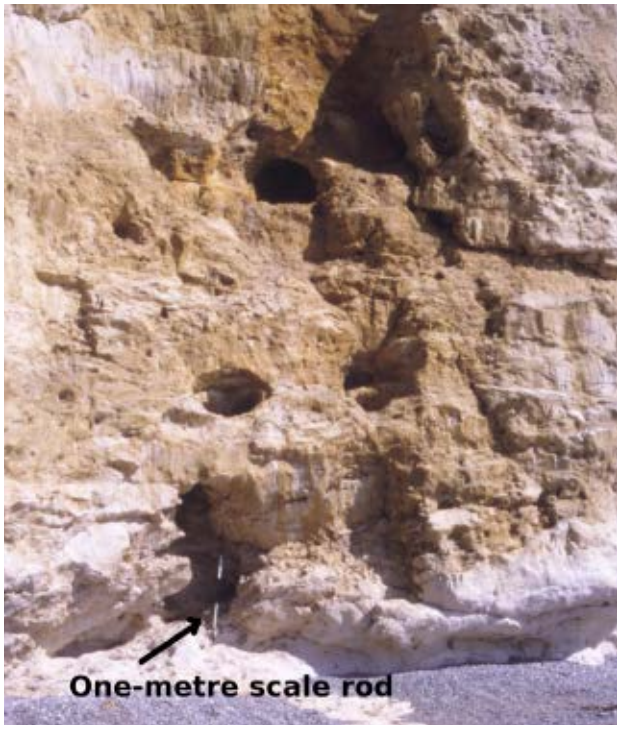

Figure 12. The multi-branched pipe ~2005

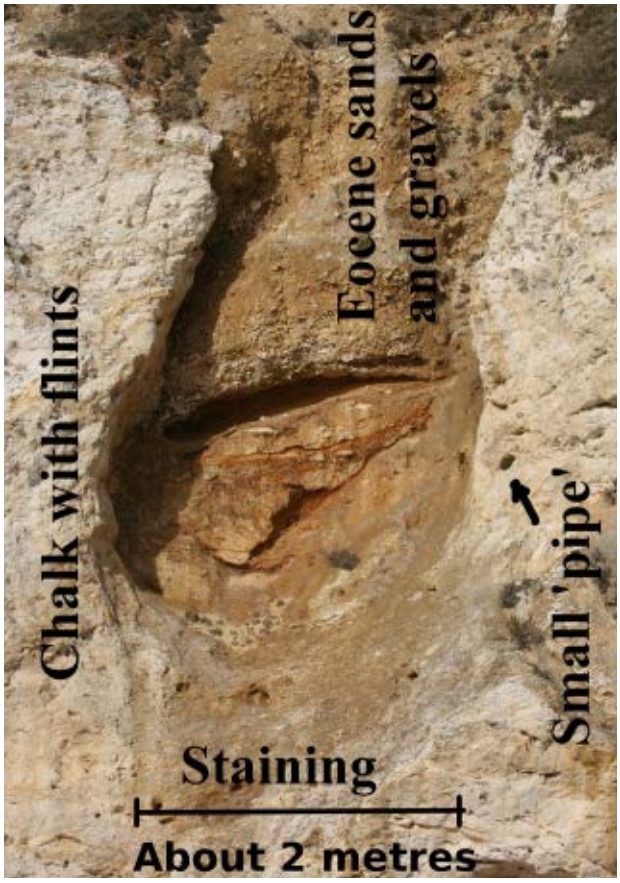

Figure 13. The most dramatic of the current 'pipes' in St Oswalds Bay

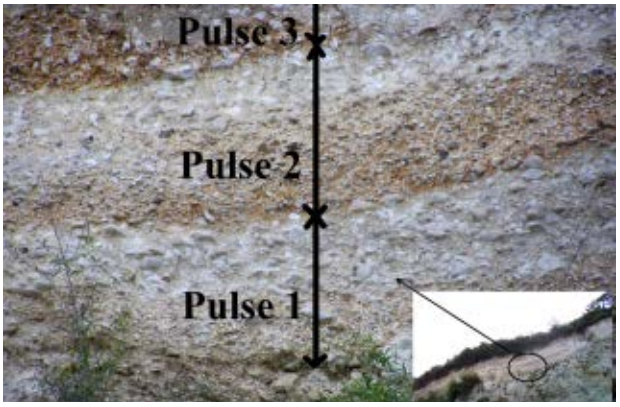

Figure 14. The 'Coombe Rock', Lulworth

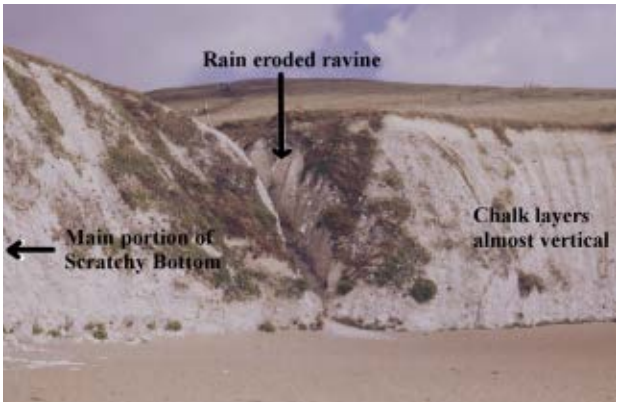

Figure 15. Evidence for fracturing at Scratchy Bottom

Lulworth Cove

The Cove has four dry valleys entering it (figure 5). The valley S1 runs from the east, and it is in a trough roughly parallel with the almost upright Wealden and other soft rocks, which are sandwiched between the chalk and the Jurassic limestone. This points to it being a direct product of the global Flood water running into what would eventually become the Cove over soft rocks. The 'coombe rock' at beach level is a rather jumbled arrangement of Wealden clays and sands. The catchment area, for rain or snow, is so limited that it rules out uniformitarian explanations based on storage followed by release of water from melted snow or breaching of ice dams. Also, the significant slope (~ 5°) rules this out as a normal near-coastal valley because it is more akin to those in mountainous regions.

One valley originates in the NE over chalk (C1). It then merges with another chalk dry valley (C2) from the west. Valley C1 is almost linear and, rather like valley S1, it followed this course because of east-west faulting (figure 8) in the chalk, opening a pathway of easily erodible chalk fragments. A further dry valley joins them from the west—namely S2. This is also over part of the chalk, strictly speaking, and not just the Wealden sands, etc. But this valley has an unusual floor. The valley slopes at about 15° to the east, the floor is almost planar but slopes NE by about 5°. This unusual disposition points to:

1. a very rapid flow of water (The Moody river equation for this slope would suggest ~100 km/h), and
2. a single pulse of surface water, otherwise smaller entrenched mini valleys would be present in the floor.

Coombe rock from these three merged valleys is observable in the cliffs at the Cove. Close access is not possible because of a steep crumbling cliff, but photographs show the important features (figure 14). At least three distinct pulses of coombe rock are observed, which may be attributed to deposition of erosional products from each of the three valleys, or at a maximum, three pulses from a single valley. The chalk fragments are slightly rounded, and that is consistent with tumbling motion as they moved down the valleys. There is a degree of segregation within each pulse, which contradicts ideas of slow and repetitive erosion from periglaciation.

Scratchy Bottom

Many of the dry valleys show a degree of taper from their apex, particularly Scratchy Bottom. The significant degree of taper supports the dry valleys having been formed by land lifting rapidly from beneath ~200 m of water. The amount of water flowing over the emerging land increases with distance from what eventually becomes each 'apex' to the respective mouths. In consequence, the depth and width of each valley increases significantly with distance from their apexes.

Scratchy Bottom also has an abrupt right-angle turn. The flow of water over the upper portion (east-west) has eroded the Wealden (much as valley S1). It then eroded southwards because fracturing in that orientation has also occurred. The water then removes the loosened chalk. Evidence for the fracture can be seen in figure 5 just beyond the figure marked by the line of *** but is more clearly confirmed at beach level (figure 15).

The final factor pointing to a single rapid pulse of water cascading south is the conical shape of the coombe rock. It is asymmetric and around 10 m higher in the west. The shape of the valley means that the water would have flowed faster on the outside of the bend to the extent of 14 m/s.[26] With velocities of this order, all the water above Scratchy Bottom (200 m) could have flowed through its 'mouth' in under an hour.

To conclude this section, we have:

1. confirmed Goudie and Brunsden's view that periglaciation cannot explain the dry valleys on the Coast, and
2. found that the evidence points to the valleys having been formed during the rapid retreat of the Noachian Flood.

Summary and further work

This study has confirmed what uniformitarians have long considered—namely that the dry valleys on the Jurassic Coast cannot be explained by periglaciation. Based on geological data going back 70 years and the author's observations over the last 20 years, the evidence suggests that these valleys were formed during a period of rapid uplift and fast movement of water, all having happened no more than a few thousand years ago. A logical extension to this interpretation is that it is consistent with the description of the tail end of the Noachian Flood in the Bible.

The study has also shown tantalising evidence that the dry valleys inland of the coast may also have been formed by the same mechanism, rather than periglaciation as assumed by uniformitarians. That in turn suggests that many regions in southern England have been declared as periglaciated when, in fact, they were not. Thus, it opens a door to further work on this region of England to examine other features of the landscape that may (or may not) point to evidence for the Flood.

Acknowledgements

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26. The formula used to establish this is the standard one for converting potential energy to kinetic energy—half the velocity squared equals the gravity constant times the height difference.

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The surprisingly complex tRNA subsystem: part 3—quality control mechanisms

Royal Truman

Dozens of transfer RNAs (tRNAs) each requiring a precise structure and properties are indispensable to translate the genetic code. Cells possess sophisticated quality control mechanisms to identity and eliminate those which are improperly formed. Enzyme complexes can recognize very small errors in processed tRNAs, such as lack of an important methylation on a single nucleotide position (m^1A_{58}) in $tRNA_i^{Met}$. Controlled degradation of malformed tRNAs occurs through several mechanisms, helping to prevent errors in cellular processes and freeing up raw materials for reuse. Additional quality control measures include multiple proof-reading checks to ensure correct tRNA anticodon pairing to the correct mRNA codon and ensuring the correct amounts of tRNAs are made available at the right time and in the correct location.
Cells cannot survive nor reproduce without the tRNA subsystem, so this must have been in place in the very first one. The quality control processes, however, are protein-based and would not have been available before they were needed without a deliberate plan. Proteins are only produced by a functioning genetic code apparatus. A putative initial primitive genetic system which generated improperly formed tRNAs and lacked any kind of quality control processes could not have provided the precision needed to ensure survival generation after generation.

The tRNA subsystem is an indispensable component of a cell's genetic apparatus, but tRNAs rely on biochemical processing by many protein-based molecular machines to work. On the other hand, the relevant proteins depend on the genetic system being already in place, possible only if the functional tRNAs already exist. The question a scientist faces is, what is supposed to have originated first?

In part 1[1] of this series we showed that tRNAs are not merely sections of RNA used as linker molecules to translate messenger RNA (mRNA) codons to produce proteins. The 5' leader sequence must be removed from precursors using complex ribonucleases constructed by RNA and proteins having virtually no similarity across prokaryotes, mitochondria and eukaryotes. Removal of 3' extensions from pre-tRNA involves both exo- and endonucleases, and introns must also be removed although the location of the splice junctions differ for eukaryotes and archaea.

Aminoacylation of tRNAs requires them to have the trinucleotide motif 'CCA' on the 3' end, which is also necessary for processing in ribosomes.[2] In some kinds of organism, the CCA is encoded on the tRNA genes and for others it is added by a complex enzyme.[3] Both schemes require elaborate processing by additional protein-based molecular machines. The pattern of alternative sources of CCA on tRNAs is unexpected if all shared a common ancestor.

In part 1 we also pointed out that kinetic studies performed on *E. coli* revealed that the enzyme to repair damaged CCA sequences also has an innate ability to discriminate against damaged tRNAs by scrutinizing the integrity of the tRNA substrate. Moreover, the enzyme recognizes three kinds of tRNA flaws—a missing $C_{74}C_{75}A_{76}$, $C_{75}A_{76}$, or A_{76}—and reconstructs the CCA-3' sequence as needed[4].

Defective tRNAs are rapidly degraded by RNA surveillance mechanisms found in all cells, preventing them from entering the ribosome machinery.[5] Structurally unstable tRNAs are also actively eliminated by first tagging them with a second CCA, leading to 3'-terminal CCACCA sequences, which serve as a specific degradation tag.[6,7,8] Here in Part 3 we will examine quality control and related features in more detail.

In part 2[9] we drew attention to the fact that many chemical modifications of tRNA nucleotides are necessary in all organisms to produce the correct clover-leaf structure, ensure rigidity, prevent undesired interactions and permit correct processing at the ribosome. The modifications are dynamic, tissue specific, respond to environmental changes, and tRNA concentrations are used as a regulatory signal in several ways to regulate the amount of translation.

1. tRNA quality control mechanisms

tRNA degradation pathways to control expression levels

Cells possess multiple pathways to degrade inappropriately processed or misfolded tRNAs and, in addition, immature tRNAs help regulate translation by interacting with the protein synthesis machinery. They also serve as intracellular signalling molecules to communicate stress.[10] But mature tRNAs are very stable with half-lives from ~9 h up to a few

days.[10] Mature mammalian tRNAs have half-lives around 100 h, so with cellular tRNA/ribosome ratios of about 10 and protein synthesis rate on the ribosome around 2–5 peptide bonds per second, charged tRNAs should be replenished every few seconds on average. But physiological needs vary greatly according to circumstances.[11]

Eraser enzymes[12] can remove chemical modifications on tRNA nucleotides within a few minutes and together with multiple regulatory factors change tRNA lifetimes and processing under a wide range of physiological conditions.[11] Other examples of regulatory dynamic fine-tuning are evident when lack of an essential amino acid and changes in glucose concentration lead to differential charging among tRNA isoacceptors.[11,13]

Surprisingly, two tRNA degradation pathways have been found, which we will summarize next.

I. 3′-5′ exonucleolytic degradation by the nuclear exosome

$tRNA_i^{Met}$, used to identify where mRNA translation is to begin, is unstable if it lacks the m^1A_{58} methylation. This modification is critically important in bacteria, archaea, and eukaryotes.[14] Unmodified $tRNA_i^{Met}$ is enzymatically polyadenylated at the 3' end and then degraded by a multi-protein complex called an exosome. It is interesting that poly(A) tails on mRNA generally specify stability for mRNA transcripts,[15] whereas in *E. coli* tRNA degradation proceeds by poly(A) addition.[10,16]. Turnover is not a trivial matter, requiring Mtr4, an RNA-dependent helicase, and other proteins comprising the TRAMP complex[17] including the two poly(A) polymerases, Trf4 and Trf5, and either Air1 or Air2, RNA binding proteins.[10]

This 3' to 5' turnover machinery likely serves as a quality control pathway that monitors both appropriate tRNA nuclear modification as well as 3' end maturation. Recent genome-wide studies indicate that as much as 50% of pre-tRNAs may be rapidly degraded by the exosome.[10]

II. 5′ to 3′ exonucleolyic degradation by the RTD (Rapid Turnover) pathway

The RTD pathway occurs in the nucleus or the cytoplasm, and acts upon tRNAs missing particular modifications on tRNAs. It appears that nuclear enzyme Rat1 and cytoplasmic Xrn1 individually contribute to tRNA turnover.[10]

Although the mature tRNAs normally have half-lives in the order of hours to days, the defective ones are degraded on the minute to hour timescale, similar to mRNA half-lives.[10]

Further screening by elongation factor Tu

tRNAs charged with activated amino acids (aa-tRNAs) are screened for correctness by the ribosome protein elongation factor Tu, providing an additional checkpoint for their use for translation purposes. EF-Tu can distinguish both precursor noncognate tRNAs and other incorrectly charged tRNA species.[18] Elongation factors, which deliver aa-tRNAs to a ribosome, are known in bacteria as EF-Tu (Elongation Factor Thermo unstable), and eEF1A in eukaryotes. These are not simple biochemicals. In *E. coli*, EF-Tu is comprised of three functional protein parts known as domain I (amino acids 1–200), domain II (amino acids 209–299) and domain III (amino acids 301–393)[19] and in humans the canonical isoform *P68104-1* has a length of 462 residues.[20]

Incorrect expression levels cause disease

Generating too few of some tRNAs would hinder producing the necessary proteins but generating too many imposes a deleterious cost to the organism. Incorrect expression of tRNA has been shown to lead to severe consequences for cells, and to cause human diseases such as cancer, and especially mitochondrial tRNA mutations are responsible for a wide range of disorders.[11,21–23]

2. Quality control of codon-anticodon selection

The thermodynamics of mRNA–tRNA base pairing are not sufficient to explain the high fidelity and efficiency of aminoacyl-tRNA (*aa-tRNA*) selection by the ribosome.[24] During initial association of ternary complex (aa-tRNA*EF-Tu*GTP) with the ribosome, codon-anticodon interactions are formed between aa-tRNA and mRNA. Based on differences in hydrogen-bond energies, aa-tRNA interaction with the correct codon is only slightly more stable than a near-cognate one. Such small differences in stability can explain a preference for correct vs incorrect tRNAs of approximately 100:1,[24] but the reliability of initial codon-anticodon recognition varies considerably. For example, anomalously high initial misreading *in vitro* of near-cognate codon by $tRNA^{His}$ and $tRNA^{Glu}$ has been reported.[25] This makes the need for subsequent proof-reading steps important, and indeed in bacteria, the average accuracy of translation is roughly 3,000:1.[24] The translation design strategy must optimize a tradeoff between speed vs accuracy of decoding.[26]

Proof-reading principles

The principle of proofreading was formulated by Hopfield[27] and Ninio[28] whereby the free energy difference, ΔG^0, between enzyme-bound noncognate and cognate substrate can be used in both an initial selection (I) and subsequent proofreading selection (F) to boost the total accuracy (A), $A=I \times F$.[29] Laboratory distillation columns are based on a similar logic.[30] A general way to implement this strategy in cells is to use the energy provided from hydrolysis of GTP or ATP coupled to discarding of incorrect substrates. In the case of ribosomes, the existence of proofreading was originally verified by biochemical data that implicated at least two distinct steps during tRNA selection (that is, initial selection and proofreading).[24]

Multistep proofreading is a good design strategy to deal with the obligatory tradeoff between efficiency and accuracy in substrate selection by enzymes occurring when a single transition state reaction is at play. When the literature refers to the proofreading step during codon translation, the aa-tRNA accommodation step is usually meant, although this can consist of more than one transition step, each contributing an enrichment factor to the desired outcome.[24,26,29] Several inter- and intramolecular interactions on aa-tRNA can impact the degree of proofreading, and these appear to be sensitive to the tRNA species.[24]

Codon-anticodon proof-reading

Each aa-tRNA is delivered to the ribosome attached to elongation factor Tu (EF-Tu) and GTP. At this point the aa-tRNA occupies the 'A site' on the 30S ribosomal subunit while still interacting with EF-Tu. The free energy differences due to base pair mismatches between the mRNA codon and the tRNA anticodon are too small to provide the observed high accuracy of tRNA selection, and the initial codon-anticodon selection is effective by a factor of about 100:1 vs similar anticodons. At least one follow-up proofreading step is necessary (figure 1).

The codon–anticodon interaction with mRNA triggers GTPase activation and the necessary energy to trigger conformation change through hydrolysis. GTP hydrolysis is followed by release of a phosphate group (P_i) and a conformational change (~100 Å) which precedes peptide bond formation. Importantly, the kinetic energy of transition state of the cognate codon-anticodon interaction is lower than for the erroneous interaction, leading to a proofreading contribution factor of typically between 15 and 60.[24]

The details of how codon recognition in the 30S subunit leads to GTP hydrolysis are still being worked out and several ribosome components are involved.[24,31] Rearrangements occurring during aa-tRNA accommodation include: (1) aa-tRNA moves from the initial conformation A/T to a so-called 'Elbow-Accommodated' (EA) conformation, (2) the aa-tRNA arm accommodates into the A-site, and (3) the 3'-CCA end of the tRNA enters the peptidyl transferase centre (PTC).[24]

A single kinetic proofreading step is not enough to account account for the fidelity of translation,[26] and both structural and kinetic data combined with energy landscape calculations indicate that the translation process involves multiple EF-Tu independent metastable states.[24,26] The rates of the various processes have been measured by pre-steady-state kinetics and single-molecule fluorescence resonance energy transfer (FRET) experiments.[26]

3. Cellular location of tRNA processing

Eukaryotes typically have much longer lifetimes and lower population sizes than prokaryotes or archaea. A robust design therefore requires more complex features to proactively enhance survivability.

tRNAs move back and forth between the nucleus and the cytoplasm in yeast, protozoa, and vertebrate cells with the aid of importin and exportin protein complexes (figure 2).[32] The tRNA biogenesis steps occur at numerous distinct subcellular locations, as discussed next.

Primary pre-tRNAs form in the nucleolus

In eukaryotes, tRNA transcription occurs in the nucleolus to generate primary pre-tRNAs from which different enzymes then remove the 5' leader and 3' tail. Some modifications occur (such as pseudouridylation) and the CCA trinucleotide gets added, generating pre-tRNAs.

Pre-tRNAs are exported to the cytoplasm

Large biomolecules such as carbohydrates, lipids, RNAs, and proteins can only cross the nuclear envelope with the help of special nuclear pore complexes, which consist of dozens of distinct proteins.[33] The pre-tRNAs mentioned above are exported to the cytoplasm[34] in a step called tRNA primary nuclear export, through nucleopore channels in an energy-dependent mechanism.[10] This exportin serves as a quality control check to enhance the delivery of correctly

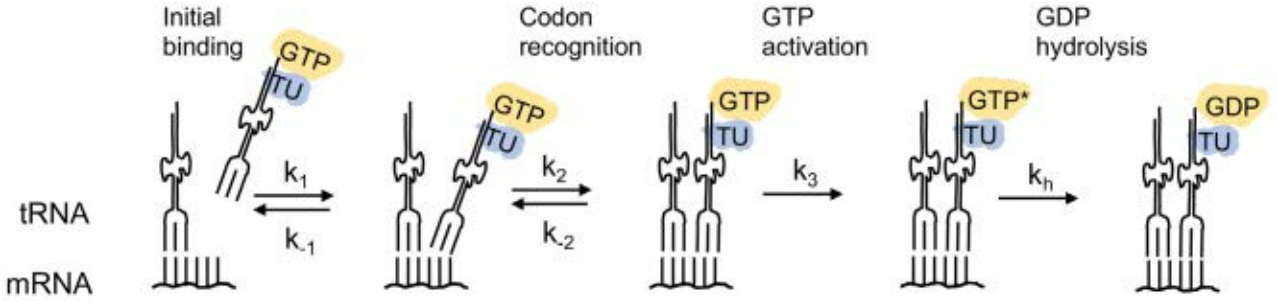

Figure 1. Multistage kinetics of decoding by ribosomes.[26] The decoding reaction, which is followed by kinetic proofreading, comprises several stages: initial binding, codon recognition, GTP activation, and GTP hydrolysis. Initial binding and codon recognition involve a complex of elongation factor (EF-Tu), GTP, and aminoacyl-tRNA which bind to the ribosome.

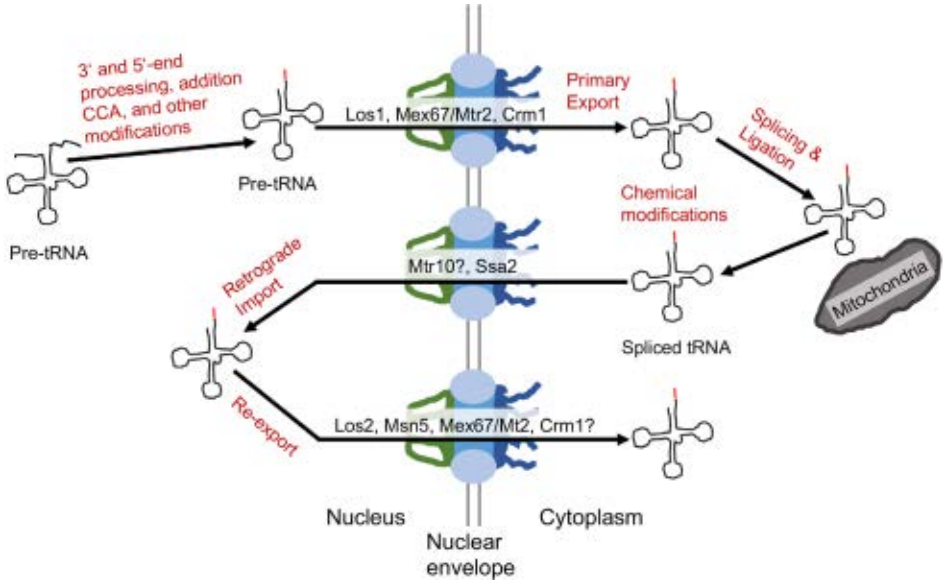

Figure 2. tRNA biogenesis and subcellular trafficking in yeast (after Hopper and Nostramo[32])

structured and processed pre-tRNAs to the cytoplasm.[34] In addition, the level of tRNA available is regulated by tRNA nuclear export.[10] This process has to be properly guided, since biomolecules don't simply diffuse into and out of the nucleus. In the model yeast *S. pombe* the Xpot protein attaches to the chemically modified TψC (figure 3) and D loops of tRNA and also interacts with both the 5' and 3' tRNA termini.

Many nucleosides are modified in the nucleoplasm and at the inner nuclear membrane, as discussed in Part 2. In yeast, tRNAs containing an intron are spliced at the surface of the mitochondria by the SEN complex and the two halves are ligated by another enzyme complex, Rlg1/Trl1.[32] In vertebrates, however, intron splicing occurs in the nucleoplasm. tRNA traffic in yeast is also known to be coordinated with the formation of P-bodies in the cytoplasm.[10]

tRNA retrograde import back into the nucleus

Spliced eukaryote tRNAs undergo a second trafficking step called *retrograde nuclear import* back into the nucleus, where spliced tRNAs no longer containing introns can be further modified and then be aminoacylated ('charged') in the nucleus.[10]

Charged tRNAs re-exported to the cytoplasm

Finally, charged tRNAs are then re-exported from the nucleus to the cytoplasm to be utilized in translation. A second importin-β family member, Msn5, is now involved. Msn5 likely exports tRNAs that have no introns to the cytoplasm and appears to specifically export those tRNAs that have been spliced in the cytoplasm and imported from the cytoplasm to the nucleus back to the cytoplasm via the tRNA retrograde re-export process.[10] Just how the appropriately processed and/or aminoacylated tRNAs are recognized by the tRNA re-export step is still poorly understood.[10]

Quality control purpose of tRNA retrograde process

Although all tRNAs have a similar tertiary structure, each species has a different RNA sequence and set of biochemical modifications added in the nucleus. There is a limited number of exporters (Los1, Msn5, and at least one unknown exporter) to transfer tRNAs from the nucleus to the cytoplasm.[35] Therefore, a given exporter must recognize multiple different tRNA sequences. This can result in errors whereby immature and/or hypomodified tRNAs are mistakenly exported to the cytoplasm.[10]

Thus, the tRNA retrograde pathway seems to serve to remove these aberrant tRNAs from the cytoplasm, returning them to the nucleus for repair and/or turnover by the nuclear RTD or TRAMP pathways, providing another mechanism for tRNA quality control.[10]

tRNA quality control by the TRAMP complex. This tRNA turnover pathway ensures that correctly crafted tRNAs are exported to the cytoplasm. An example flaw would lack m^1A_{58} transformation in $tRNA^{Met}_i$ leading to an altered interaction between the tRNA D and T loops. The pathway (which includes the complex of proteins comprised of Trf4, Air1/Air2, and Mtr4) recognizes unmodified $tRNA^{Met}_i$ and activates nuclear exosome to degrade it.[34]

The TRAMP complex[17] also acts with Rex1, an exonuclease enzyme, to recycle tRNAs with unprocessed 3' extensions. Similar TRAMP complexes and nuclear exosomes exist in archaea, *S. pombe*, and humans.[34]

tRNA quality control using a rapid tRNA decay pathway. This occurs in both the nucleus and the cytoplasm. Unmodified tRNAs in yeast are degraded via a second pathway—the rapid tRNA decay (RTD) pathway. For example, $tRNA^{Val}$(AAC) lacking the m^7G modification (figure 3, catalyzed by Trm8) and m^5C (figure 3, catalyzed by Trm4) has a half-life typical of only minutes, instead of hours or days typical of fully modified tRNA.[34]

4. Charged tRNAs participate in autoregulation

A recent RNA immunoprecipitation study revealed for every tested aaRS (aminoacyl-tRNA synthetase) a far

better association with the mRNA coding for it than to other mRNAs.[36] How might this function in this case? Detailed work using the HisRS protein showed that the binding location was very similar to the $tRNA^{His}$ anticodon loop. The authors increased the levels of uncharged $tRNA^{His}$ and this led to increased HisRS translation. Apparently HisRS binding to the mRNA was hindered, and translation could proceed.

Other RNA-binding proteins (RBPs) are known to be autoregulated and some ribosomal proteins are also known to bind their own mRNA.[36] mRNA binding leads to translation inhibition, although the mechanisms are not understood yet.[36]

Discussion and conclusions

tRNAs must satisfy a daunting number of constraints in order to translate all coding codons specified by the genetic code. They all must possess a very narrowly defined folded shape to allow proper recognition by the ribosome components. But simultaneously, in order to obtain sufficient diversity to permit unambiguous recognition by the synthetases to charge the correct activated amino acid to the correct tRNA CCA sequence, an unusually complex series of chemical modifications are needed (discussed in part 2), requiring dozens of specialized enzymes for all organisms.

All forms of life on Earth require a functioning genetic code, and evolution could not prepare one or a few tRNAs first, then countless generations later add another tRNA gene, and then another, since during the evolving process most of the codons could not be translated. There is no simple starting point.

In the section above we drew attention to how cells perform many complex quality control processes, such as:

- Multiple proof-reading steps to ensure correct codon-anticodon pairing
- Two tRNA degradation pathways to ensure that unsuitable tRNAs are eliminated
- Elongation factors can identify incorrectly charged tRNA species
- Degradation of $tRNA_i^{Met}$ which lack the m^1A_{58} chemical transformation, indispensable to ensure a stable tRNA structure.

However, the many proteins needed for each of these processes could not have been produced before tRNAs existed, so naturalists must assume none of the quality control mechanisms were available until long after the genetic code was fully functional. Recall from part 1 that the genetic system consists of several mutually dependent subsystems, and without a functional genetic code cells cannot survive. Therefore, a putative genetic system with no quality control anywhere would mean uncontrollable errors generated during each of the processes involved, such as during DNA to mRNA transcription, DNA to DNA replication, charging of amino acids by synthetases, translation of codons, folding of proteins, etc.

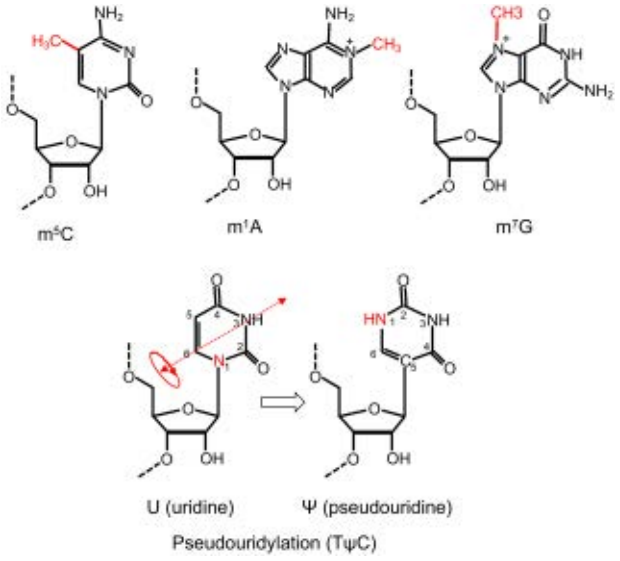

Figure 3. Enzymatic chemical modifications on tRNAs referred to in this paper

Consider the impact of multiple sources of errors. Part 1[1] and part 2[9] of this series showed that without many chemical transformations by protein-based enzymes most tRNAs are unsuitable. Chemical transformations are particularly important to ensure that Start and Stop codons are not misinterpreted by coding triplets having only one nucleotide difference.[37] Now in part 3 we see that the flawed ones would not be recognized and degraded in an evolutionary scenario. Consider the outcome. $tRNA_i^{Met}$ is used to identify where mRNA translation is to begin. If not positioned just right the 3-nucleotide reading frame to translate codon after codon won't align correctly. (Of course, in a primitive ribosome it is not clear why each tRNA would only find its cognate codon right next to the just translated codon instead of anywhere on the mRNA, so utter translational chaos would be expected). Now we learn that an enzymatic transformation on $tRNA_i^{Met}$ is necessary but that a quality control process to identify the malfunctional ones would not have existed initially.

Finally, without the necessary protein-based molecular machines, the correct amount of the right kinds of tRNAs under the correct circumstances cannot be regulated. The result would be a genetic system hopelessly lacking key components, with high error rates for each key process, over and under generating the proportion of biomolecules needed.

We conclude in part 5 of this series[38] that evolution cannot create a minimally functional genetic code based only on our analysis of the tRNA subsystem, and also that evolving various additional complex tRNA-related features lies beyond what theoretical evolutionary processes could achieve.

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The surprisingly complex tRNA subsystem: part 4—tRNA fragments regulate processes

Royal Truman

tRNA-derived small RNAs consist of *tiRNA*s and *tRF*s. Generation of tiRNAs is stimulated by stress conditions such as amino acid deficiency, oxygen deprivation, UV radiation, oxidative damage, heat shock, phosphate starvation, arsenite, and viral infection. They are involved in cell-to-cell communication, immune signalling, cell-state transitions, and in suppressing tumour formation and metastasis. tRFs regulate expression of messenger RNA, apoptosis, cell growth, and epigenetic inheritance, suppress movement of transposable elements, interact with the immune system, modify chromatin organization, and regulate translation by displacing initiation factors or displacing mRNA from the initiation complex. Some tRFs auto-regulate their own concentration by binding to the aminoacyl-tRNA synthetases responsible for their production. Clearly, cells are top-down, intelligently planned systems having crosstalk between genetic subsystems, designed for robustness, adaptability, and self-regulation.

In part 1[1], part 2[2] and part 3[3] of this series we examined the complex enzymatic processing necessary to generate functional tRNAs. Dozens of protein-based molecular machines were therefore necessary from the very beginning for the genetic code to work. In part 5,[4] we will consider whether evolution is a plausible explanation for these findings.

Here in part 4, we will discuss additional biological services provided by tRNAs and also by degradation fragments generated from tRNAs. Instead of being worthless RNA fragments, these are used for important regulatory purposes. The intention of this paper is to help gain a more comprehensive picture of the vast number of interacting processes involved in a cell and how to interpret this fact. Evolutionists assume that life must have started very simple and complexity was added incrementally through a vast number of individual fortuitous accidents upon which natural selection could then act. An understanding of what needs to be explained in a reasonable amount of detail is necessary before blindly assuming that natural, unguided chemistry is causally sufficient to provide a feasible pathway from an abiogenetic state to functioning cells.

tRNA cleavage products had been considered biologically irrelevant for more than three decades. This is the kind of error which results from the wrong mindset, that cells should be as simple as possible to make evolution credible. Given the vast number of kinds of tRNA fragments and very low concentrations of most of them, many scientists were blinded by their presuppositions to thinking these did not merit serious research.

The tRNA world is now so vast that all the processes affected and regulated are almost beyond comprehension.[5] The potential for utter cellular chaos is overwhelming without an initial master plan as the basis for carefully implemented controlled activities.

We will point out next that tRNAs do more than only serve as linker molecules to translate codons.

tRNAs regulate protein translation

It is common for individual cellular components to be used for multiple purposes, analogous to how a metal gear or software subroutine is reused in different contexts. Modular designs based on standardized elements are characteristic of well-engineered systems. It is now known that tRNAs collaborate in many cellular activities in eukaryotes, bacteria, and archaea beyond serving only as adaptor molecules. Generally, the concentration of uncharged tRNAs in cells is low, so when translation slows down for any reason free tRNA serves as a signal to regulate other linked processes. For example, free tRNA can interact with the protein kinase[5] MEK2 and thereby inhibit the latter's activity, slowing down cell-cycle progression until translation can resume at full capacity.[6]

As another example of translation regulation, under stress or nutrient limitation the amount of uncharged tRNA increases, activating the kinase GCN2. This then increases phosphorylation of the eukaryotic initiation factor eIF2α thereby hindering delivery of the initiator $tRNA^{Met}$ to the ribosome. The result is also a slowdown of translation.[6]

tRNAs involved in non-translation processes

Many tRNAs are also involved in other pathways which are not related to genetic code translation,[7] for example in the first step of heme and chlorophyll biosynthesis, as reverse

transcription primers, and for strand transfer during retroviral replication.[8] tRNAs can interact with the cytochrome C protein preventing it from binding to the caspase activator Apaf-1, thus helping to regulate apoptosis (cell suicide for the good of an entire organism).[6] Eukaryotic tRNAs participate in targeting proteins for degradation via the N-end rule pathway,[8] which helps regulate protein concentrations to the necessary levels.[9]

Aminoacylated tRNAs involved in non-translation processes

Aminoacylated tRNAs (aa-tRNAs) are also involved in non-ribosomal peptide bond formation, post-translational protein labelling, modification of phospholipids in the cell membrane, and antibiotic biosynthesis.[10]

Regulation with tRNA-derived small RNA

So far, we have focused on tRNA molecules, and now we will examine RNA degradation fragments derived from them. tRNA-derived small RNAs (tsRNAs) have been identified in all domains of life, and aberrant tsRNA expression is linked to several diseases such as cancer and neurological disorders.[11–14] Since this is still a new area of research, a consistent nomenclature to describe these specially crafted fragments has not been established yet.[15] Online databases of tsRNAs are available,[16] which also include those derived from tRNAs encoded by organelles such as mitochondria and chloroplasts.[11]

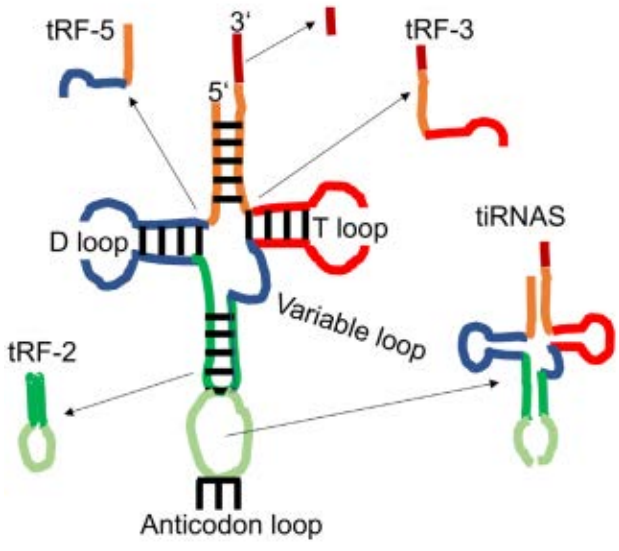

Figure 1. tRNA-derived small RNAs generated by various ribonucleases. tRNA-derived stress-induced RNAs (tiRNAs): 5′ tiRNA and 3′ tiRNA are cleaved from the anticodon loop. tRNA-derived fragments (tRFs): these consist of four families, called tRF-1s, tRF-2s, tRF-3s, and tRF-5s.

Even though the same kinds of tsRNAs are formed, many of the enzymes used (ribonucleases) by eukaryotes are different than those found in bacteria and archaea, and these ribonucleases are often tRNA-type specific.[15] We propose that this is best explained as examples of different designs used in order to solve similar requirements in an optimal manner.

Three key enzymes are involved in the generation and maturation of tsRNAs, namely RNase Z, Dicer, and angiogenin[14] and the non-coding RNA fragments generated from cleavage of both tRNA and pre-tRNA participate in regulating several cellular processes,[17] including the cellular RNA interference (RNAi) system.[10]

Studies on tsRNAs have revealed commonalities with the better-known miRNAs (micro-RNAs).[18] Like miRNAs, tsRNAs are also known to base-pair with complementary sites of mRNA (messenger-RNA) to prevent their translation.[17]

The presence of virus can stimulate the production of tsRNAs which are able to interfere with reverse transcription of RNA of virus origin. The abnormal expression of tsRNA has been shown to be strongly associated with various diseases, such as tumours, the cardiovascular system, epigenetics,[19] and neurological diseases[14], but properly expressed help hinder cancerous growth.[17]

There are two families of tsRNAs (figure 1): tiRNAs and tRFs, which we will discuss next.

tiRNAs (tRNA-derived stress-induced RNAs)

tiRNAs, also called *tRNA-halves*, are cleaved specifically in the anticodon loop to produce two fragments: 30–35 nucleotide (nt) long 5'-tRNA halves and 40–50 nt 3'-tRNA halves[20] (figure 2). The enzymes responsible for this cleavage are Rny1[12] and angiogenin (ANG), a member of the pancreatic RNase superfamily,[13] but the mechanisms have not been worked out in detail yet. ANG targets preferentially the dinucleotide 'CA' pattern in single-stranded RNA, with ~20-fold higher preference for CA over UA and 3-fold higher for CA over CG.[13]

tiRNAs are produced almost exclusively under stress conditions, for example, amino acid deficiency, hypoxia (oxygen deprivation), UV radiation, oxidative damage, heat shock, phosphate starvation, presence of arsenite, and viral infection,[12,17] promoting assembly of stress granules[21]. Studies indicate that tiRNAs might also react to environmental challenges via mechanisms that do not involve the well-known integrated stress response.[13] For example, tRNA cleavage was not observed in other forms of stress investigated, like γ-irradiated, etoposide-treated or caffeine-treated human cells.[13]

The concentration of mature tRNA is not significantly altered by formation of tiRNAs. Less than 5% of the tRNA pool is cleaved, and only 5'-tiRNAs, but not 3'-tiRNAs

inhibit translation in cultured cells. Moreover, only tiRNAs derived from $tRNA^{Ala}$ and $tRNA^{Cys}$ have been shown to be responsible for the inhibition,[20] and the nature of cleavage is regulated according to type of tissue. The level and composition of tiRNAs have also been shown to change with age and calorie intake.[13]

tiRNAs are believed to help suppress metastasis and tumour formation.[22] Fragments introduced into breast cancer cells decreased cancer growth, whereas inhibition of these fragments increased the cancer phenotype.[13] ANG-induced tiRNAs are also involved in the cellular response to virus infection[13] and can act as signalling molecules that participate in cell-to-cell communication and in immune signalling.[13] Thus, tiRNAs can serve as biomarkers to detect stress-induced tissue damage, which is important since uncontrolled tissue damage is a common underlying cause of cancer (figure 2).[13]

Several studies have shown that various diseases result if tiRNA expression is dysregulated under stress conditions[14], and modification of specific nucleosides seems to help regulate their expression by providing resistance to ANG-induced cleavage in tRNAs during stress responses.[13]

There is also a group of special tiRNAs known as sex-hormone-dependent tRNA-derived RNAs, found in breast and prostate cancer cell lines, which are not produced under stress conditions.[14]

A comprehensive study involving several institutes from India and Singapore examined how specific tiRNAs are involved in cell-state transitions using mouse embryonic stem cells. They found differential enrichment in a broad range of cell states.[23]

tRFs (tRNA-derived fragments)

The second family of tsRNAs consist of tRNA-derived fragments (tRFs**)** which are 18–22 nt in length (figure 1). These tRFs have been found in all domains of life, but the processing details are different. For example, eukaryote tRFs which are produced inside the nucleus must be exported into the cytoplasm.[24]

tRF are not irrelevant degradation products

The evidence includes several observations: (a) tRFs are not always derived from the more abundant tRNAs, nor do the numbers of tRFs correlate with the gene of the parental tRNAs; (b) fragmentation patterns depend on the specific parental tRNA; (c) fragmentation patterns change according to developmental stage or cellular conditions; and (d) some tRFs are bound to Argonaute/Piwi proteins, well-known components of the RNA-induced silencing complex.[25]

Compared with randomly degraded fragments, tRFs possess at least the following three characteristics: (1) remarkable site-specificity; (2) defined lengths; and (3) significantly higher abundance. This allows them to be reliably identified using computer tools.[26]

In one detailed study[25] the expression levels of mitochondrial and nuclear tRFs were found to differ significantly during the six stages (the egg, 1^{st}–4^{th} instar larvae, and adult) of the tadpole shrimp *Triops cancriformis*, a 'living fossil' whose morphological form is claimed not to have changed in almost 200 million years. The total read number of nuclear tRFs was 412 times larger than the number of mitochondrial tRFs and the amount of tRFs deriving from each kind of parental tRNA varied considerably. For example, among the mitochondrial tRFs, tRF^{Ser}(GCU) was most abundant (30.1 %).[25] In the case of nuclear tRF, 72.9% derived from only one kind of tRNA, $tRNA^{Gly}$(GCC).[25]

Aberrant tRNAs are a source of RFs

tRFs are extracted from tRNAs and tRNA precursors by nucleases Dicer and RNase Z.[17] In particular aberrant and

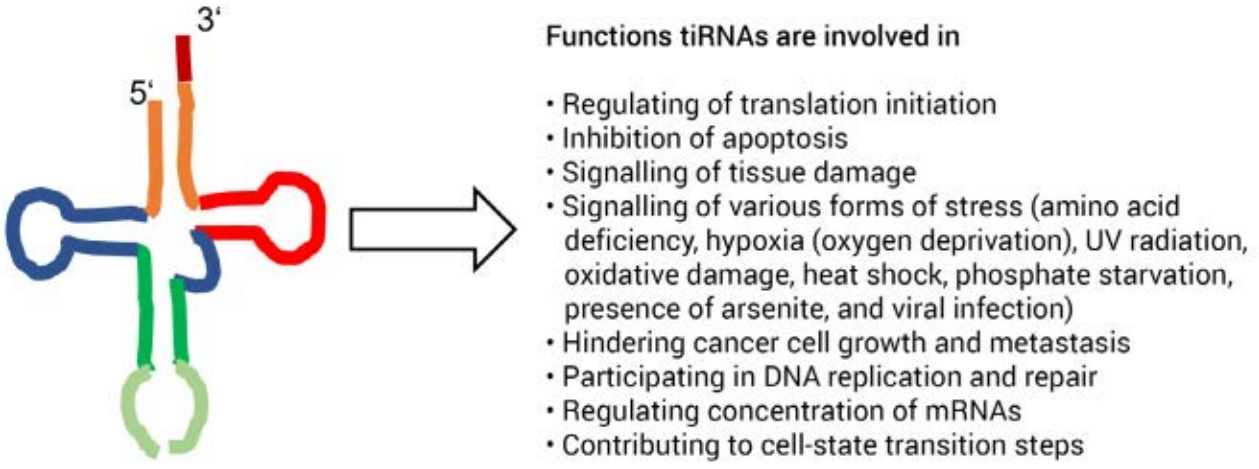

Figure 2. Formation of tiRNAs (tRNA halves) and some biological functions they participate in

misfolded tRNAs are recognized and cleaved,[15] serving a quality control function. But tRFs also play many useful cellular functions directly. They form in response to various cellular stresses (e.g. oxidative stress, UV irradiation, and nutrient starvation) and those correctly formed are often protected from degradation by addition of various ligands.[24]

There are four types of tRFs

Many researchers distinguish between tRF-5s, tRF-3s, tRF-1s, and tRF-2s, classified based on the part of the mature tRNA or pre-tRNA from which they are derived (figure 1)[17] but the abundances of tRF-1s and tRF-2s are usually considerably lower than of tRF-3s and tRF-5s.[14] The tRF-5s are further classified by their lengths: tRF-5a (14–16 nts), tRF-5b (22–24 nts), and tRF-5c (28–30 nts) and the lengths of these tRF-5 series follow a normal distribution.[14]

Generally, tRF-1s vary in length depending on the location of a termination signal within each precursor tRNA.[34] Since tRNA genes can come in multiple variants, this leads to a variety of tRFs which then provide a means to help regulate different processes in more precise manners. This design-centric interpretation views the existence of multiple tRNA gene copies not as the result of meaningless accidental gene duplication events but planned variety and adaptability.

tRFs are involved in translation-related cellular processes

Evidence is accumulating that tRFs can regulate translation, by displacing initiation factors or by displacing mRNA from the initiation complex. Studies revealed that 18-nt 5' tRFs having the terminal oligoguanine (TOG) motif modified to pseudouridine (Ψ) at the eighth uridine position can inhibit global translation, whereas the normal uridine-bearing 18-nt 5' tsRNAs cannot.[12,27] It requires much credibility to believe that countless examples like these of extreme specificity executed by complex enzymes to perform key cellular processes, arose by random mutations.

Another study found that a valine tRNA-derived fragment (Val-tRF) produced under certain stress conditions in eukaryotes and archaea can bind to the small ribosomal subunit. This then displaces mRNA from the initiation complex, decreasing the amount of protein formed.[28] In *S. cerevisiae* both 5'- and 3'-parts of tRNA fragments can bind directly to ribosomes,[29] but to different sites. These interactions are stress-dependent and inhibit protein synthesis.[29] In other words, there exists a prepared solution able to react almost instantly when the problem arises.

The tRF interactions with key proteins of the translation machinery, whether ribosomal proteins or translation initiation factors, rely on sequence-specific binding.[11] Using data from several *Drosophila* genomes, the authors of one study reported that the 7-nt target sites associated with a reduced translation efficiency were perfectly complementary to the respective 5'tsRNAs.[11] Intriguingly, examples are also known of increases in translation for at least two ribosomal proteins by binding to sequence-complementary target sites that presumably lie within the coding sequence of their mRNA.[11]

Some tRFs assemble into intermolecular G-quadruplexes (RG4s), structures consisting of four guanine molecules which interact with each other through Hoogsteen hydrogen bonding and are further stabilized by cations like Na+ and K+.[30,31] Selected 5'tiRNAs (e.g. tiRNA^{Ala} and tiRNA^{Cys})

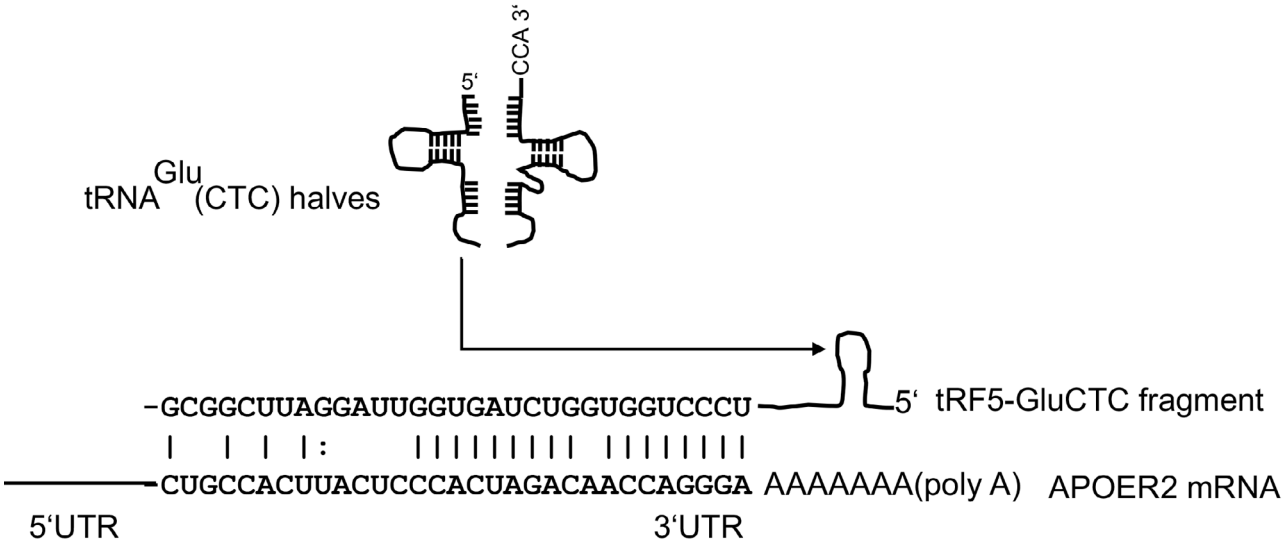

Figure 3. Sequence alignment of tRF5-GluCTC with APOER2. The interactive region was identified by both RNAhybrid analysis and the binding assays. The 3'-portion of tRF5-GluCTC recognizes a target site in the 3'-untranslated region of APOER2 and suppresses its expression.[35]

bearing the terminal oligoguanine (TOG) motif (four to five guanine residues) at their 5'-termini displace translation initiation factor eIF4A/F/G from mRNAs.[12]

Some tRFs can also bind to the exact aminoacyl-tRNA synthetases involved in producing their parent tRNA.[12,14] In yeast, they were reported to bind to ribosome-associated aminoacyl-tRNA synthetases and thereby at least *in vitro* inhibit translation by regulating tRNA aminoacylation.[12] This is an example of feedback self-regulation, which causes an overproduced biomolecule to slow down its own creation. Robustness and regulation to ideal concentrations are typical of intelligently designed engineered systems.

tRFs can mimic the principle used by miRNAs to fine-tune translation rates by interacting with mRNAs. A statistical analysis of a dataset generated from The Cancer Genome Atlas representing 32 types of cancer revealed a multitude of statistically significant and context-dependent associations between various tRFs and mRNAs.[32] The tRF-mRNA circuitry was found to depend on a patient's gender and the expression levels of tRFs are also known to change with oncogene[33] activation and cancer progression regulating the occurrence and development of tumours.[34]

One particular tRF fragment, $tRF5^{Glu}$(CTC) (tFR5-GluCTC) is predicted to be able to bind to at least 44 mRNAs with a minimum free energy of ≤ -30 kcal/mol,[35] which is typical of miRNAs. This is of interest and known through medical research because infection by the Respiratory Syncytial Virus (RSV) interferes with these 44 mRNAs and RSV can deactivate the host immune defences combating it. The mRNA of a specific target of tFR5-GluCTC, apolipoprotein E receptor 2 (APOER2) was predicted to have the best binding and was examined in depth[35] (figure 3). APOER2 was shown to inhibit RSV replication by interacting with key RSV protein(s),[35] so interfering with APOER2's mRNA would *enhance* the virus survival. This is exactly what happens upon infection by RSV: this induces production of tRF5-GluCTC, leading to a lower level of APOER2.[35] We will speculate on the significance of this from a design point of view below.

Several variants of tFR5-GluCTC were synthesized to provide fewer nt pairing with APOER2, and the effect of exposure to RSV was examined. Surprisingly, the fewer and dispersed pairings at the 3' end of tFR5-GluCTC were found to affect concentration of APOER2 most strongly.

Two facts may point to a design purpose behind a virus with RSV-like properties. First, it seems noteworthy how many genes can be regulated by tFR5-GluCTC, around 44. In addition, APOER2 belongs to a class of lipoprotein receptors which *promote* the replication of some Flaviviruses via endocytosis.[36] Perhaps the original design and intention was to use some viruses to regulate genes, endowed also with autoregulation. One can envision that the correct amount of APOER2 could control how much of a virus would survive and thereby regulate dozens of mRNAs. It is well established that there are diseases caused by malfunctioning regulation. The concept is shown in figure 4.

Some scientists, such as Dr Peter Borger from *Wort und Wissen* in Germany, have suggested that viruses seem to have originally been encoded on genomes for useful purposes, reminiscent of transposable elements, but mutated and became transmissible and harmful as a consequence of the Fall.[37]

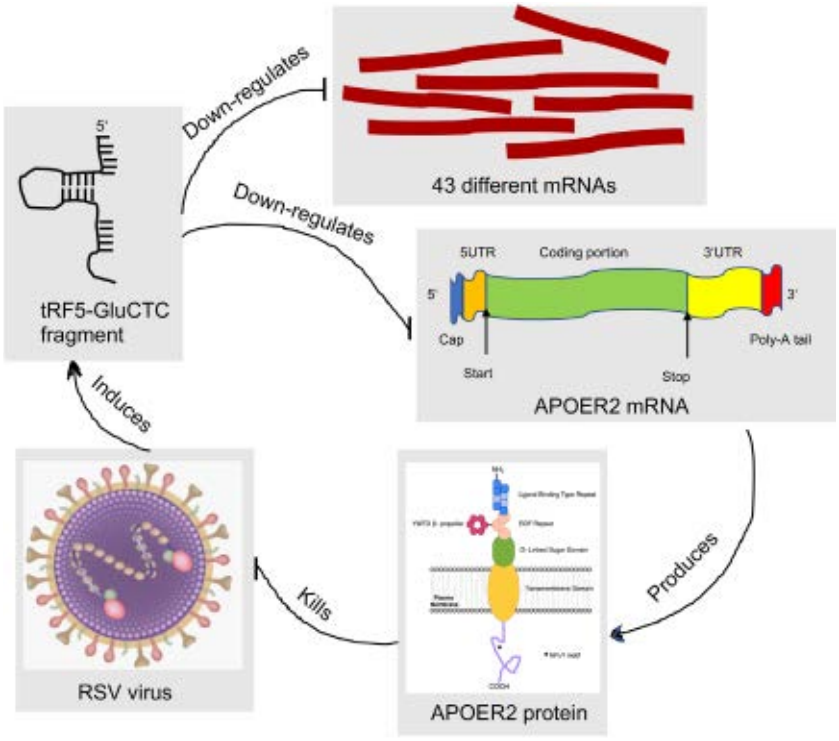

Figure 4. RSV (Respiratory Syncytial Virus) viruses may have originally served a regulatory function to fine-tune the expression level of dozens of mRNAs. RSV induces production of a key tRNA fragment 'tRF5-GluCTC' which is believed to interact with at least 44 mRNAs in the manner of miRNAs.[35] tRF5-GluCTC decreases the concentration of a key protein APOER2 (by interacting with its mRNA) which then prevents growth of RSV by interacting with a key replication-necessary protein.[35] The net effect can be autoregulation of dozens of mRNAs if the right ones are targeted in the correct manner. This must be correctly regulated or lead to disease. It is conceivable that originally RSVs were not transmissible between organisms, causing the damage seen currently by viruses.

tRFs are also involved in non-translation-related cellular processes

tRNA fragments are important for a wide range of biological processes, and millions of small tRNA-derived molecules can interact with cellular proteins and mRNAs.[6]

Torres and colleagues at the Barcelona Institute of Science and Technology detected several examples of significant differences in expression level among genes in the same isodecoder[38] affecting tRFs levels but not that of mature tRNAs.[39] Variations of individual isodecoder genes should not affect translation timing or amount, so their experiments reinforce the new understanding that tRNA genes are often also involved in regulating functions which are not related to serving as adaptor molecules for mRNA translation.

Indeed, tRFs are an emerging class of regulatory RNAs which play a role in producing various noncoding RNAs—snoRNAs, scaRNAs, and snRNAs[17]—and participate in many processes, a few of which we will mention next.

Modify chromatin organization

tRFs can modify chromatin organization processes.[40]

Regulate apoptosis and cell growth

Some tRFs are involved in initiating and inhibiting apoptosis,[24] and cell viability after cell damage.[14] tRFs have also been reported to participate in cell growth.[14]

Epigenetic inheritance

tRFs can also be directly involved in epigenetic inheritance in germ-line cells, affecting the metabolism of offspring. Key studies showing this were performed on low-protein-diet mice whose sperm showed markedly different tiRNAs concentrations.[19,41,42]

Suppress movement of transposable elements

tRFs can suppress reverse transcription and retrotransposon mobility and can silence long terminal repeat (LTR) retrotransposons.[17]

Interact with miRNA-based mRNA silencing process

As research in tRFs progressed it became apparent that several miRNAs had been incorrectly annotated and are actually derived from tRNAs.[15] Alternative gene sources of mature miRNAs are now known, so that miRNAs are not always generated from hairpin pri-miRNA (primary microRNA) structures. This poses no problem if cellular processes were designed in advance, but evolutionary attempts occurring through random mutations would create an endless potential for interference with mRNAs.

Some tRFs take part in globally controlling small RNA silencing through competitively combining with one of the key Ago[43] family proteins.[17] Although these tRFs can deactivate mRNAs, unlike miRNAs, the target sites of mRNAs are distributed through all regions, including the 5'-UTR (untranslated region), CDS (coding sequence), and 3'-UTR.[12] Once again, the potential for interference is overwhelming, with the wrong mRNA targets being affected without an initial top-down design and implementation.

On-going research is uncovering ever more layers of regulation. A novel class of tRF-2s derived from tRNA(Asp), tRNA(Tyr), tRNA(Gly), and tRNA(Glu) was discovered recently, able to inhibit various oncogenic[33] mRNAs from stabilization thus helping to fight cancerous growth.[17]

Interact with the immune system

During the acute inflammatory stage, tRFs are significantly upregulated in blood circulation, implying a function in immune regulation. Investigations have demonstrated that tsRNAs can directly interact with a key receptor to activate immune responses in some lymphocytes.[14]

Discussion and conclusions

We began this series with the assumption that the collection of tRNA linker molecules seemed like the simplest subsystem of the genetic system since presumably only RNA is involved. This assumption was shown to be wrong in parts 1–3, since extensive biochemical processing is necessary for tRNAs to work, carried out by protein-constructed molecular machines. Now we see that the tRNAs and their degradation fragments play many additional important biological roles and communicate with various processes, some indirectly related to translations and others completely unrelated.

tRNAs are integrated into auto-regulation schemes such that translation is slowed down when substantial amounts of non-charged species are present as signals, and tRNAs are also integrated with cell-cycle progression. However, evolution's lack of foresight prevents any planning of translation regulation before code translation even existed (especially when the same parts will serve multiple purposes). The examples presented involve precisely crafted interaction between tRNAs and protein complexes. Thus, our major conclusion is that the ensemble of tRNAs also includes several parts which are irreducibly complex. Evolution processes cannot begin with just RNA and somehow evolve an entire genetic system. This will be further explored in part 5.[4]

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The 'windows of heaven' are figurative: reading a 'solid sky' into a biblical metaphor is a big mistake

Keaton Halley

The phrase 'windows of heaven' (or 'windows in heaven') is used six times in Scripture (Genesis 7:11; 8:2; 2 Kings 7:2,19; Isaiah 24:18; Malachi 3:10). Many scholars insist that the biblical authors believed these 'windows' to be literal openings in a solid sky, based on a prescientific cosmology they allege the Israelites to have held. Eleven principles drawn from Scripture are proposed and defended to show that these windows were not meant to refer to literal openings but were intended as metaphors for the regulation of heavenly provisions, including rain from clouds.

Creationists are often accused of taking the Bible too literally. Ironically, though, it is frequently the critics of creationism who mistake the Bible's metaphors for woodenly literal descriptions, based on a prescientific cosmology they attribute to the ancients. One example of this concerns the 'windows of heaven' mentioned twice in the Flood account (Genesis 7:11; 8:2) as well as four other places in Scripture (2 Kings 7:2,19; Isaiah 24:18; Malachi 3:10). According to many liberal scholars and some professing evangelicals like Paul H. Seely,[1] Kyle Greenwood,[2] and John H. Walton,[3] people of the ancient Near East (ANE) universally believed that the sky had a solid ceiling, often thought to be vaulted. Allegedly, multiple cultures of the ANE—including that of the biblical authors—further affirmed that above the vault was a vast cosmic ocean. The biblical 'windows of heaven', these scholars say, were considered to be literal openings in the vault (figure 1) which allowed the upper waters to rain down at the time of Noah's Flood.

When one examines the contexts of these phrases and the entirety of the biblical testimony on the subject, however, it is clear that references to 'windows' in heaven were intended as idioms for the control of rain and other heavenly provisions. It is a mistake to think that the biblical authors considered these windows to be literal openings in the sky, as the following 11 principles collectively indicate.[4]

1. The biblical authors knew that rain came from clouds.

It should be no surprise that people dependent on the weather for their livelihood would have a basic understanding of the connection between rain and clouds. The Bible is filled with references to both clouds and rain which demonstrate this understanding. Here are a few representative examples:

> "The clouds poured out water …" (Psalm 77:17).
>
> "In the light of a king's face there is life, and his favor is like the clouds that bring the spring rain" (Proverbs 16:15).
>
> "If the clouds are full of rain, they empty themselves on the earth …" (Ecclesiastes 11:3).
>
> "Ask rain from the LORD in the season of the spring rain, from the LORD who makes the storm clouds, and he will give them showers of rain, to everyone the vegetation in the field" (Zechariah 10:1).
>
> "He also said to the crowds, 'When you see a cloud rising in the west, you say at once, "A shower is coming." And so it happens'" (Luke 12:54).

Furthermore, there are no passages clearly demonstrating that the Israelites believed in a second source of rain—an upper sea—or that the clouds themselves had to be supplied with water from such a sea. All the texts which are alleged to show that rain comes directly or indirectly from an upper sea have more plausible alternative interpretations, as the following principles will show.

2. The Bible speaks interchangeably of rain from clouds and rain from the heavens because these sources of rain are equivalent, not separable.

Just as the Bible states that rain comes from clouds, it also says that rain comes from the heavens (e.g. Psalm 68:8; Isaiah 55:10). Such passages are not describing a second source of rain apart from clouds. Clouds belong to the heavens,

so when clouds give rain, the heavens can be said to give rain. Indeed, at least one passage uses poetic parallelism to signify that rain from clouds and rain from the heavens are synonymous descriptions of a single event:[5]

> "… the earth trembled and the heavens dropped, yes, the clouds dropped water" (Judges 5:4).

3. The Bible uses several man-made objects as metaphors for clouds.

In Job 38:37, God asks who is able to "tilt the waterskins of the heavens", in context clearly referring to clouds dropping rain. This cannot be taken literally, as the description fits neither clouds nor the supposed vault windows, since neither of these resemble a pouch made of animal hide, nor do they release water by tilting.

In another example, God's authority in heaven is asserted by asking, rhetorically, "Who has gathered the wind in his fists?", and "Who has wrapped up the waters in a garment?" (Proverbs 30:4). It is easy to see this as a poetic description of clouds, since clouds consist of waters gathered in heaven as if bundled by a cloak. Rather than postulate that the biblical authors invoked a multiplicity of physical mechanisms to control rain, it is better to acknowledge that they simply employed picturesque analogies to describe clouds. Metaphors such as these suggest that texts mentioning 'windows of heaven' might likewise be speaking figuratively. To make this determination, one must also consider the immediate contexts of those passages, which will be addressed below.[6]

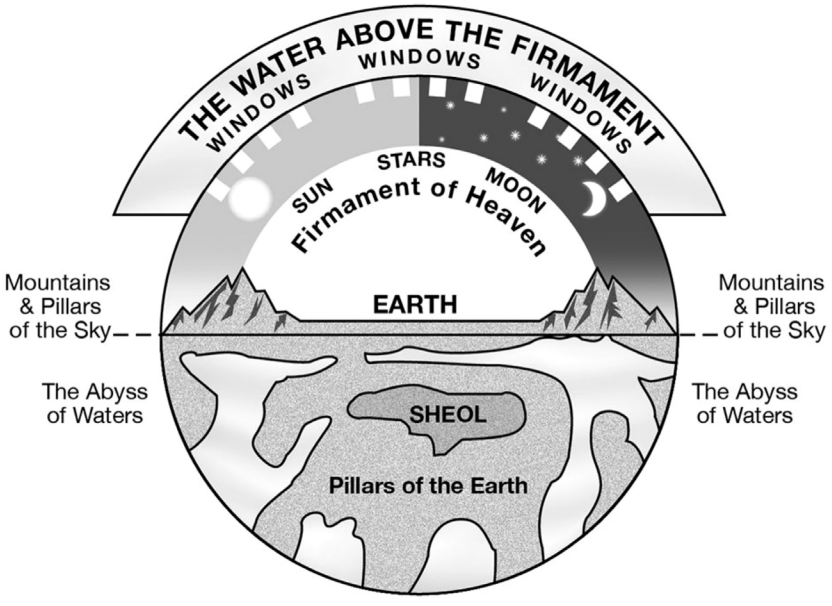

Figure 1. "Biblical view of the cosmos" according to Greenwood, K., *Scripture and Cosmology*, p. 26, 2015. This misrepresentation of the biblical view is typical, erroneously portraying literal 'windows' in heaven.

4. The Flood account suggests that clouds were the source of the Flood's rain.

In the Flood narrative, clouds are not mentioned by name when "the windows of the heavens were opened" and rain fell for 40 days and nights (Genesis 7:11–12). Neither are they mentioned at the time when "the windows of the heavens were closed, the rain from the heavens was restrained" (Genesis 8:2). But after Noah came out of the Ark God set His rainbow "in the cloud" as a symbol of His promise never to Flood the world again (Genesis 9:13). Most significantly, He promised to remember His covenant in the future, specifically: "When I bring clouds over the earth and the bow is seen in the clouds" (Genesis 9:14). The point of mentioning future gatherings of clouds and the choosing of a sign situated in the clouds was that it was likely to reassure Noah and his descendants that they need not fear that future storm clouds might cause another great Flood. This suggests that storm clouds were a significant cause of the Flood just experienced. Hence, there is good reason to think that the author of the account expected readers to understand that the Flood's rain came from clouds, not from actual physical windows. (See principle 9 for additional evidence based in part on the Flood narrative that clouds were responsible for this rain.)

5. The Bible never states that clouds are supplied with water from an upper sea.

No biblical passages demonstrate, or even hint, that clouds are fed from higher waters. Clouds are not said to descend from a vault or catch water that drips from the windows of heaven. Apart from the windows mentioned in the Flood account and generic references to the heavens giving rain (both already addressed above), solid-sky advocates have little to offer here. The best they can do to connect rain with an upper sea is point to Psalm 104:13 and similar texts, which speak of God sending rain from His heavenly dwelling place—located just above heavenly 'waters' (cf. Psalm 29:3–10; Amos 9:6). Both Walton[7] and Greenwood[8] assume these texts portray God's residence perched atop a celestial ocean, and that *these* are the waters God sends as rain. Sadly, they are reading their preconceived views into these passages. For example, the relevant part of Psalm 104:13 simply says, "From your lofty abode you water the mountains".

There is nothing in this text to lead one to believe that God's abode is

located in an alleged 'upper heavens' above the sky roof and on top of a celestial sea. On the contrary, the beginning of this chapter explains where God's 'lofty abode' is to be found:

> "Bless the LORD, O my soul! O LORD my God, you are very great! You are clothed with splendor and majesty, covering yourself with light as with a garment, stretching out the heavens like a tent. He lays the beams of his chambers on the waters; he makes the clouds his chariot; he rides on the wings of the wind; he makes his messengers winds, his ministers a flaming fire" (Psalm 104:1–4).

The imagery here involves an oft repeated motif in Scripture, in which the visible heavens are portrayed as God's tent, house, or temple. As pictured, God is clothed in the light of heaven (and in similar texts He is surrounded by the sun and stars—cf. Job 22:12; 37:21–22; 1 Kings 22:19; Isaiah 14:13–14). The supporting rafters for the upper story of God's house are laid on 'waters' (v. 3). What waters are these? A vaulted ocean? No, they are clouds, as the text immediately goes on to reveal. It depicts God's presence in clouds and amid other atmospheric phenomena, just as the Old Testament frequently does elsewhere. There are numerous passages in which God is portrayed as walking on, or riding through, the clouds as on a chariot or a cherub.[9] The table below reveals how pervasive this portrayal of God is throughout the Old Testament.

Psalm 104, consistent with the rest of the Old Testament, uses these devices to depict God as though He lives in the physical, observable heavens. He is bathed in the light of the visible heavens and He waters the mountains from His loft in the visible clouds. An invisible upper sea far above this realm is not indicated, and thus is not presented as a source of rain.

6. Rather than acquiring water from an upper sea, the Bible indicates that clouds arise from seawater below.

If they are not supplied by a heavenly ocean, does the Bible say how clouds do accumulate water? Admittedly, Scripture is not terribly specific about cloud formation. Yet several passages seem to be relevant. In a few places, gathering clouds are said to rise from the sea or from distant parts of the earth.

> "He it is who makes the clouds rise at the end of the earth, who makes lightnings for the rain and brings forth the wind from his storehouses" (Psalm 135:7).

> "And at the seventh time he said, 'Behold, a little cloud like a man's hand is rising from the sea.' And he said, 'Go up, say to Ahab, "Prepare your chariot and go down, lest the rain stop you."' And in a little while the heavens grew black with clouds and wind, and there was a great rain" (1 Kings 18:44–45).

> "When he utters his voice, there is a tumult of waters in the heavens, and he makes the mist rise from the ends of the earth. He makes lightning for the rain, and he brings forth the wind from his storehouses" (Jeremiah 10:13; cf. 51:16).

These descriptions could be purely phenomenal. That is, they may only describe the fact that clouds 'rise' by appearing 'low' on the horizon and 'high' when overhead, despite maintaining a fairly constant altitude throughout their approach. Nevertheless, it seems likely that the biblical writers believed and expressed here the idea that mists and clouds do physically rise up from the sea and ascend vertically into the sky. They had experience with low clouds and fog (Job 38:9; Ezekiel 38:9, 16), and could have witnessed the behaviour of clouds at different elevations in the sky. The Israelites surely could have observed mists rising—coming off puddles and other bodies of water, as in the phenomenon of 'steam fog' (figure 2). They were undoubtedly familiar with steam travelling upward from boiling water, too, and they would have noticed that this diminished the water in their cooking pots.[10] It would not require any advanced scientific knowledge of evaporation and condensation to realize that water can ascend in the form of mists or vapours. Although it's not exactly clear how much the biblical writers understood about these subjects, the above passages give prima facie evidence that they at least associated cloud formation with rising, if not drawing water from seas and other bodies of water on earth.

Imagery of God's relationship to clouds	Old Testament references
Enthroned upon clouds	Psa. 29:3–10; 97:2–6; Isa. 14:13–14; Dan. 7:9, 13
Walks upon clouds	2 Sam. 22:7–15; Job 22:12–14; Psa. 18:9–14; Nah. 1:3
Rides upon clouds	Deut. 33:26; 2 Sam. 22:7–15; Psa. 18:9–14; 68:4, 33–34; 104:1–4, 13; Isa. 19:1
Surrounds Himself with clouds	2 Sam. 22:7–15; Job 37:2–22; Psa. 18:9–14; 97:2–6; Lam. 3:44
Resides in a structure composed of, or built upon, clouds	2 Sam. 22:7–15; Job 36:27–33; Psa. 18:9–14; 68:33–35; 104:1–4, 13; Amos 9:6
Speaks through thunder (often associated with clouds since it occurs during rainstorms)	Exo. 19:19; 2 Sam. 22:14; Job 37:2–5; 40:9; Psa. 18:13; 29:3–10; 68:33–34; 104:7

Intriguingly, two passages in Amos portray God specifically calling waters up out of the sea in order to pour them back down as rain:

> "… who calls for the waters of the sea and pours them out on the surface of the earth …" (Amos 5:8; cf. 9:6).

To my knowledge, no one has suggested that the 'sea' in these verses refers to a liquid ocean above the sky roof rather than the sea on earth. The Hebrew term for 'sea' (*yam*) is never used anywhere else in Scripture to refer to waters in heaven—not even as a figure for clouds, let alone a celestial ocean. Also, the action of pouring in the second line of the couplet requires the water to be coming from above as rain, not merely coming from the sea and flooding onto the land. Therefore, Amos apparently understood that clouds are formed by waters ascending from earthly seas.

Psalm 33:7 may also speak of God collecting water from the sea to form clouds. The ESV translates it thus:

> "He gathers the waters of the sea as *a heap*; he puts the deeps in storehouses."

If 'heap' is the correct rendering, this would refer to God piling up the water in the ocean. But the NRSV has it thus:

> "He gathered the waters of the sea as in *a bottle*; he put the deeps in storehouses."

If the NRSV is correct, this verse likely depicts God lifting waters out of the sea to form clouds—as though clouds were containers made of animal hide, similar to the way they are portrayed as 'waterskins' in Job 38:37. The difference between the two translations is due to the (uninspired) vowel pointing of one Hebrew word. Without the vowels, which were added by interpreters, the word could be read as either *ned* (a heap) or *nod* (a skin bottle). This term does refer to heaps of water elsewhere (Exodus 15:8; Joshua 3:13, 16; Psalm 78:13), but these verses all speak of water that was miraculously piled up when God parted the Red Sea and the Jordan River. It is less clear whether a 'heap' is a fitting way to describe the waters of the sea in their natural state.

One point in favour of the NRSV rendering is that the Septuagint (ancient Greek version of the Old Testament) translated the term in question as *askos* (skin bottle). Furthermore, the term 'storehouses' in the second line is only used elsewhere in reference to *heavenly* treasuries. Heaven's storehouses are said to contain atmospheric phenomena like rain, snow, hail, and wind (Job 38:22; Psalm 135:7; Jeremiah 10:13; 51:16), yet the term is never applied to storage in the sea. So, while it's not beyond question, Psalm 33:7 at least arguably adds further weight to the several passages that portray God as drawing water from the sea to make clouds.[11]

Figure 2. Steam fog on the Atlantic Ocean

7. The opening of the heavens can refer to ordinary seasonal rain from clouds.

> "The Lord will open to you his good treasury, the heavens, to give the rain to your land in its season and to bless all the work of your hands" (Deuteronomy 28:12).

The term 'windows' is not used in this passage, but the heavens are likened to a 'treasury' that can 'open', resulting in rain. Greenwood takes the reference to the treasury as a literal storage area for rainwater,[12] but this cannot be. For one thing, a treasury, or storehouse, is a space in which one stockpiles valuable goods like food or money, not typically a large body of water. This suggests the treasury is figurative. Furthermore, in the Hebrew, the terms 'treasury' and 'heavens' are each preceded by the accusative particle *'et*, marking them both as direct objects of the same verb. This means the idea being communicated is not the opening of a treasury *in* the heavens, but the opening of a treasury; *namely*, the heavens. Heaven itself *is* the treasury, which is observably not literal.

This verse also implies the operation of clouds. Clouds are not mentioned by name, but, given principles 1–3 above and principle 10 below, they were undoubtedly viewed as the means by which rain came. The text specifically identifies this rain as that which would be given "in its season" and the term for rain is *matar*, which is often used of seasonal rain (Deuteronomy 11:14; Job 29:23).[13] Seasonal rain was surely understood to come from clouds as the pattern would have been familiar to anyone paying attention. Ergo, the 'treasury' is a metaphor for heaven's abundant supply of rain from clouds to grow crops. Its 'opening' has nothing to do with windows in a solid sky. Plus, given the similarity in concepts, this is further evidence that the opening of the 'windows of heaven' in the Flood account (Genesis 7:11) has nothing to do with a solid sky either.

Interestingly, unlike Greenwood[14] and Walton,[7] who characterize the biblical view of precipitation as regulated by sky windows, Seely does not attribute ordinary rain to the windows or to the upper sea. In his view, the Bible depicts the windows of heaven being opened only during Noah's Flood, not thereafter. He claims that "the waters above the firmament are excluded from the normal everyday universe" and that "they only entered this world one time: at the time of Noah's flood—something God promised never to do again".[15] But, in effect, this concedes that the opening of the heavens,

as expressed in Deuteronomy 28:12, must be a metaphor for rain from clouds. Seely's position is inconsistent. Why take the opening of the heavens to be literal in one case and not the other? More examples of heaven's opening and shutting will be considered below.

8. The opening of the heavens can deliver other things besides water, including intangibles.

If all of the passages which mention the opening of the heavens and storehouses in the heavens are to be taken literally, there must be quite a few separate storage units above the vault, making it a complex and crowded place. After all, solid-sky proponents must not only posit compartments for various forms of precipitation (rain, snow, hail) and other atmospheric phenomena (wind), they also need a garage full of manna.

> "Yet he commanded the skies above and opened the doors of heaven, and he rained down on them manna to eat and gave them the grain of heaven" (Psalm 78:23–24).

Are we to believe the Israelites thought there were literal chambers full of manna up above the vault, somehow kept dry and stored alongside all the other bins next to, or within, the heavenly sea? Some solid sky proponents seem to believe so, because if the windows of heaven are literal, then the doors must be as well.[16] Nonsense. This is clearly metaphorical language.

Moreover, this psalm specifically connects the opening of heaven's doors with God's command to the 'skies' (Hebrew *shehaqim*). The term *shehaqim* often means 'clouds' (e.g. Job 38:37) and may carry that meaning in this instance. It is translated as 'clouds' in this passage by the HCSB, NASB, NET, and NKJV. But even when *shehaqim* does not refer to clouds, it typically refers to open skies.

Walton has a peculiar view that *shehaqim* refers to multiple solid barriers separating different levels of heaven,[17] but this is untenable. In Deuteronomy 33:26 God is said to ride both the 'heavens' and the *shehaqim*. The preposition is not supplied in the Hebrew, but it could mean that God rides in, on, across, or through these things. In any case, God is not riding around on multiple solid floors of heaven beyond where the Israelites could see. His practice of riding through the sky is a common motif in Scripture, and He is always depicted as riding in the *visible* heavens—through the air on wind, clouds, and flying cherubim (see table and discussion in section 5). So, *shehaqim*, in both Deuteronomy 33:26 and Psalm 78:23–24, would have been understood by God's people as either 'clouds' or 'spacious skies', not solid dividers between various heavens. Hence, it is most natural to understand the doors of heaven metaphorically.

Besides that, other passages using the exact phrase 'windows of heaven' outside of the Flood account reveal that these windows can deliver intangible things like 'a blessing' (Malachi 3:10) or various kinds of judgment (Isaiah 24:18). Also, when "the heavens were opened" in Ezekiel 1:1, God could be seen. Invisible and intangible things like these cannot be kept in storage rooms above a solid vault and accessed through physical openings, as the Israelites well knew. Once again, all indications point to the metaphorical nature of heaven's windows.

9. When the heavens are 'shut up', all rain ceases.

The Bible not only refers to the heavens being opened, but also shut.[18] If solid-sky advocates were consistent, they would see these as references to the closing of literal sky hatches, not the prevention of rain from clouds per se. In that case, clouds would still be able to drop the water they had stored up before their supply from above was cut off. Furthermore, if clouds were known to accumulate water without help from an upper sea as some of the above principles argued, then there is even less reason to think they would be affected by the sealing up of that alleged sky sea. Yet the Bible makes clear that the shutting of the sky entails that all rain ceases.

> "The fountains of the deep and the windows of the heavens were closed, the rain from the heavens was restrained …" (Genesis 8:2).

> "… then the anger of the LORD will be kindled against you, and he will shut up the heavens, so that there will be no rain, and the land will yield no fruit, and you will perish quickly off the good land that the LORD is giving you" (Deuteronomy 11:17).

> "When heaven is shut up and there is no rain because they have sinned against you, if they pray toward this place and acknowledge your name and turn from their sin, when you afflict them …" (1 Kings 8:35; cf. 2 Chronicles 6:26).

> "When I shut up the heavens so that there is no rain …" (2 Chronicles 7:13).

The rain stopped altogether because, to say that 'heaven is shut up' or that 'the windows of the heavens were closed' just meant that clouds would no longer give rain. Actual trap doors in a sky roof were never intended.

10. When clouds do not rain, all rain ceases.

In Isaiah 6, God tells a parable about a vineyard which represents Israel and Judah. He speaks words of judgment against the vineyard, including this statement:

> "I will also command the clouds that they rain no rain upon it" (Isaiah 5:6).

The implication is that the vineyard would receive no rain at all. To accomplish this goal, God only issued a command to the clouds. He did not also command the windows

of the sky to close in order to prevent rain from this alleged second source. But this is not because the sky windows were permanently closed since the Flood, as Seely would have it. We have already seen that Seely's proposal is hopelessly inconsistent with all the other references to the heavens being open and shut at other times. Rather, the most natural conclusion is that God uttered no separate command to sky windows because there was no need. The Israelites knew that rain comes from clouds alone.

11. Counterfactual statements about the creation of heavenly windows shows they were not believed to actually exist.

One remaining passage that speaks explicitly of windows in heaven actually argues against their literal existence. The following question is put to Elisha:

> "If the LORD himself should make windows in heaven, could this thing be?" (2 Kings 7:2; cf. 2 Kings 7:19).

Solid-sky advocates cite this passage as evidence for their view.[19] But if ancient readers thought that the sky already contained windows, then it makes little sense to consider a hypothetical scenario in which God might have to create windows in order to shower down blessings from above. Rather, this passage militates against the idea of literal sky windows. The speaker took it for granted that currently there were no windows in heaven, and even the hypothetical ones he entertained could be non-literal. It would be like saying, 'If God would drill some holes through these clouds, we could see the sun.' Such a statement would neither prove that clouds already had holes drilled, nor that clouds are made of a solid substance capable of being drilled. The statement is meant to be a vivid word-picture and nothing more. So it is with windows in heaven.

Conclusion

The foregoing arguments should make it clear that Scripture's 'windows of heaven' must be understood contextually as metaphors for the regulation of heavenly provisions, including rain from clouds. When one interprets the Bible through a prejudicial 'ancient cosmology' filter, one winds up distorting the Bible's true meaning. Turning the windows into physical objects over-complicates the biblical picture of the heavens and undermines the plain sense of its many colourful references to clouds and weather. The biblical authors were not advancing bogus ANE perspectives in their usage of idioms, so scholars should stop accusing them of being so naive. As far as the 'windows of heaven' go, the Bible's use of the phrase is an example of literary artistry, and it is perfectly consistent with everything man has since discovered to be true about the structure and behaviour of the cosmos.

References

1. Seely, P.H., The Firmament and the Water Above, part II: the meaning of "The Water above the Firmament" in Genesis 1:6–8, *WTJ* **54**:31, 1992.
2. Greenwood, K., *Scripture and Cosmology*, InterVarsity Press, Downers Grove, IL, pp. 55, 82–85, 95–97, 2015.
3. Walton, J.H., *Ancient Near Eastern Thought and the Old Testament*, Baker Academic, Grand Rapids, MI, pp. 168–170, 2006.
4. See also similar points admirably made by Poythress, V.S., *Interpreting Eden*, Crossway, Wheaton, IL, ch. 9, 2019, and my review: Halley, K., Keen insights into Genesis 1–3 flawed by analogical days approach, *J. Creation* **33**(3):14–18, December 2019.
5. Isaiah 45:8 likely furnishes a second example. The ESV renders this: "Shower, O heavens, from above, and let the clouds rain down righteousness." It is true that this Hebrew term for 'clouds' (*shehaqim*) can also be translated as 'skies' in some contexts. Yet the primary meaning of the term is 'clouds' and the context of Isaiah 45:8 favours that option. Walton argues against the translation of *shehaqim* as clouds, but I address his view under principle 8.
6. The few references to the 'windows of heaven' occur more frequently in narrative passages than poetic ones, but it is the particulars of the immediate context that favour a figurative meaning, not the genre of the text as a whole.
7. Walton, ref. 3, p. 170.
8. Greenwood, ref. 2, pp. 96, 117.
9. This symbolism may even have had a polemical purpose against various weather gods of antiquity, like Ba'al, who are similarly described in contemporary pagan literature with epithets such as 'Rider of the Clouds'.
10. They also knew that bodies of water could dry up (Isaiah 19:5; Nahum 1:4).
11. Job 36:27 may also allude to water ascending from earth to become clouds, if it is meant to convey the idea that God "draws up the drops of water" (ESV). Though that is a possible rendering, the term 'up' is not present in the Hebrew. The verb means 'withdraw'. Given the parallel line which speaks of distilling (filtering), I think the more likely meaning here is that God draws raindrops out of a cloud, not up into one.
12. Greenwood, ref. 2, p. 96.
13. Stadelmann, L.I.J., *The Hebrew Conception of the World*, Pontifical Biblical Institute, Rome, pp. 115–116, 1970.
14. Greenwood, ref. 2, pp. 95–97.
15. Seely, ref. 1, p. 34. But there is tension even within this paper as Seely later cites some rabbis who speculated that clouds received water from the upper sea (p. 37). Presumably, Seely would reject this supposition.
16. Stadelmann, ref. 13, p. 125.
17. Walton, J.H., *Genesis 1 as Ancient Cosmology*, Eisenbrauns, Winona Lake, IN, pp. 155–161, 2011.
18. The Hebrew verb *atsar* (עָצַר), which is used in 4 out of 5 passages cited here, has the primary meaning of 'hold back', but can also mean 'close, shut up'. Botterweck, G.J., Ringgren, H., and Fabry, H. (Eds.), *Theological Dictionary of the Old Testament*, vol. 11, Eerdmans, Cambridge, UK, p. 311, 2000.
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Molecular and morphological analysis predicts four bat baramins

Matthew Cserhati

Bats are intriguing creatures, being the only winged mammals. However, the species' relationships within bats are not exactly known. Due to differences between megabats and microbats, bats might be an apobaramin. Thus far, only morphology-based baraminology studies have been performed on bats, suggesting the level of the baramin at or below the family. In this study, a morphological data set from 28 species was analyzed and suggests four bat groups. Additionally, the mitochondrial DNA of 130 bat species was analyzed, yielding four putative baramins. The four groups are: Megachiroptera, Rhinolophoidea+Emballonuridae, Vespertilionoidea, and Noctilionoidea. Analysis using the WGKS algorithm suggests that Megachiroptera and Vespertilionoidea form baramins, whereas Noctilionoidea could possibly be an apobaramin. This means that from a molecular viewpoint, the level of the baramin appears to be at the superfamily/suborder level. Also, whereas morphological methods were able to discern only Megachiroptera and Rhinolophoidea, molecular methods were capable of higher resolution in predicting the other two main groups.

Bats (order Chiroptera) are interesting creatures because they are so obviously unrelated to all other mammals. Among all mammals, only bats are capable of true, sustained flight. Other mammals are either terrestrial or can only glide, such as Dermoptera (flying lemurs, or colugos). Bats are clearly an apobaramin since they show such obvious discontinuity with all other forms of life. However, internally the relationships between species and the number of holobaramins are not clearly known.

Taxonomists differ as to how bats are classified. There are two basic ways of classifying bats. According to one classification scheme, Chiroptera is made up of two suborders, with around 1,100–1,300 species, which are broken up into about 20 families: the suborder Megachiroptera (megabats, otherwise known as fruit bats or flying foxes) and Microchiroptera (microbats). Megabats mainly eat fruits, and roost in trees, and usually move around by sight and smell. On the other hand, microbats mainly eat fruits, fish, nectar, and blood, and move around mainly by echolocation.[1]

According to another known classification scheme based on the comparison of gene expression similarities in the brain, Chiroptera can be divided into the suborders Yinpterochiroptera, including megabats and the microbat families Nycteridae, Craseonycteridae, Rhinopomatidae, Rhinolophidae, Hipposideridae, and Megadermatidae, which comprise the superfamily Rhinolophoidea. All other microbat families form the suborder Yangochiroptera.[2] The global genomic similarity between megabats and the associated six microbat families has also been supported by the study of the nuclear genes A2AB, BRCA1, RAG1, RAG2, vWF, and three mitochondrial genes, 12S and 16S RNA, and tRNA valine.[3]

The several significant genetic, morphological and ecological discontinuities between bats described above imply that bats are not monophyletic. Rather, they could form several holobaramins.

What makes bat baraminology challenging is the fact that bats look similar to one another on a general level. Despite their difference in size, megabats could even form one large holobaramin with microbats, just as lions and housecats both belong to the same holobaramin, yet are very different in size. There are several instances where similar species from a larger taxonomic group appear to comprise multiple baramins. For example, previous baraminology research has delineated multiple turtle,[4] squid,[5] and seal[6] baramins. Many authors who have studied bats claim that microbats are paraphyletic, which means that it is very possible that there are several microbat baramins besides the megabat baramin. The fact that multiple lineages could have arisen after the Flood within a single kind is another factor that makes bat baraminology more challenging.

Previous studies have shown that genome size correlates with metabolic rate in some vertebrate groups. Among all mammals, bats have the smallest genomes.[7] They also have a smaller mean chromosome number (38) than the mammalian average (44), but do not show any clear relationship between chromosome number and genome size. On average, megabats tend to have smaller genomes compared to microbats, and are quite constrained in size.[8] In megabats, the number of LINE-1 elements decreases with genome size.[9] Transposable elements are thought to be active in some species of bats.[10] The number, type, and distribution of transposable elements could prove useful in determining bat baramins, as it has

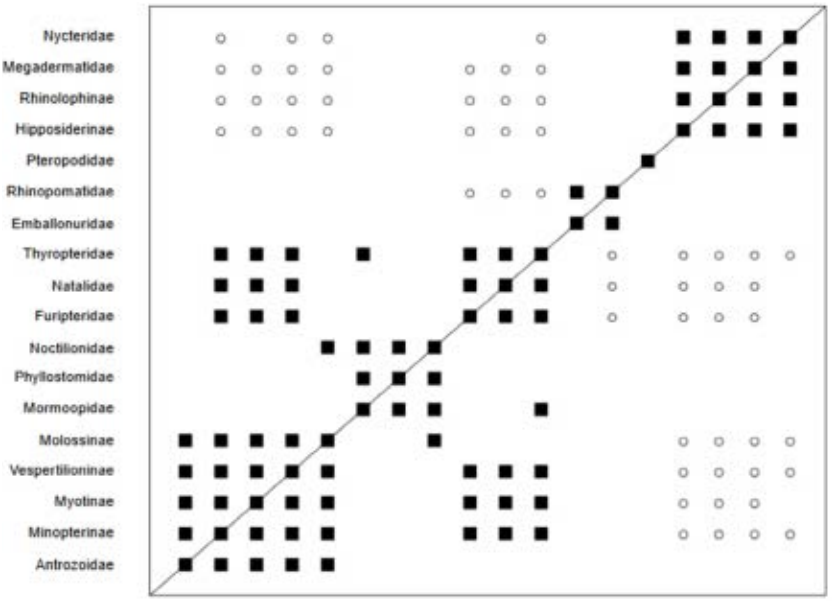

Figure 1. Baraminic distance graph of the 30 species in the morphology study. Four groups can be seen. From top left to bottom left: Rhinolophoidea, two outgroups, Megachiroptera, and all other microbats.

in the case of other baramins, such as *Caenorhanditis* and *Mycoplasma* and *Ureaplasma* species.[11,12]

A previous morphology-based baraminology study on bats suggested the following baramins: Desmodontinae, Glossophaginae, Noctilionidae, Pyllostomidae, and Stenodermatinae.[13] This implies that with bats, the level of the baramin is at or just under the level of family. Since there is difficulty in separating bat baramins from one another based on physical traits, a genetic approach might be more productive.

To this end, the Whole Genome K-mer Signature (WGKS) algorithm was used on 36 species of bats. Besides this, the mitochondrial DNA sequence of 130 bat species was also analyzed. A separate morphology study consisting of 28 bat species was also performed to compare morphological and molecular results.

Materials and methods

A data matrix containing 208 morphological characters for 28 bat species and two outgroups (Scandentia and Dermoptera) was acquired from a publication by Simmons and Geissler.[14] Missing characters '-' were recoded to '?'. Entropy filtering was performed allowing at most 33% unknown values for all species and all characters based on procedures in Cserhati.[15] A minimum entropy value of 0.1 was set for each character. This led to a 1.95-fold reduction in data, and a loss of 48 characters, leaving 20 species after the filter. Scandentia and Dermoptera were excluded from the analysis. The filtered data matrix was analyzed with the BDIST software at [coresci.org/bdist.html] using a character relevance cutoff of 0.95.[16,17] The stress plot is also available at this website. Baraminic relationships were also depicted in a 3D MDS plot created by the KiNG software.[18]

The whole genome sequences (WGS) of 36 bat species and the mitochondrial DNA (mtDNA) sequence of 130 species were downloaded from the NCBI database. The species are listed in supplementary files 2 and 3, available online. The mtDNA sequences were aligned with Clustal Omega at the EBI website at ebi.ac.uk/Tools/msa/clustalo/,[19] and the identity matrix was derived from the alignment using BioEdit.[20] The Pearson Correlation Coefficient (PCC) matrix was derived by using the WGKS algorithm on these 36 WGSs using octamers.[21]

The heatmap was made in R, version 3.6.0, using the 'heatmap', using the 'median' method for the mitochondrial DNA analysis, and the 'mcquitty' method for the WGKS analysis. Clusters were determined using the 'cutree' command. The histogram showing the distribution of PCC values was made with the 'hist' command.

Supplementary files for this study are available at creation.com/molecular-and-morphological-analysis-of-bat-baramins.

Results

Biblical analysis

In Genesis 1:20–21 (ESV), we read about the creation of the sea creatures and flying creatures:

> "And God said, 'Let the waters swarm with swarms of living creatures, and let birds fly above the earth across the expanse of the heavens.' So God created the great sea creatures and every living creature that moves, with which the waters swarm, according to their kinds, and every winged bird according to its kind. And God saw that it was good."

Here the Hebrew word that is translated bird is עוֹף, or 'oph'. According to Strong's Hebrew lexicon, this term (#5775) denotes winged birds with feathers. The Brown-Driver-Briggs' Hebrew lexicon says that this term (#5895) includes all flying things, such as insects as well. This is a collective term which includes all flying creatures: fowls, bats, insects, and pterosaurs. Since bats are flying mammals, they would be included in this category. They are clearly separate from

land animals, which were created on Day 6 of Creation Week.

Bats are specifically mentioned in three other parts of the Bible: Leviticus 11:19, Deuteronomy 14:18, and Isaiah 2:20. Leviticus 11:19 and Deuteronomy 14:18 are both lists of unclean flying creatures. Bats may have been considered unclean since they are carriers of many kinds of viruses. Isaiah 2:20 (ESV) says:

> "In that day mankind will cast away their idols of silver and their idols of gold, which they made for themselves to worship, to the moles and to the bats."

Though this verse doesn't mention bats explicitly as unclean animals, since they are brought into association with idolatry, one can suspect that bats are unclean. Leviticus 11:19 and Deuteronomy 14:18 mention bats only in a generic sense, without any subdivisions. However, just because the Bible doesn't talk about bats in more detail doesn't necessarily mean that they are necessarily monophyletic.

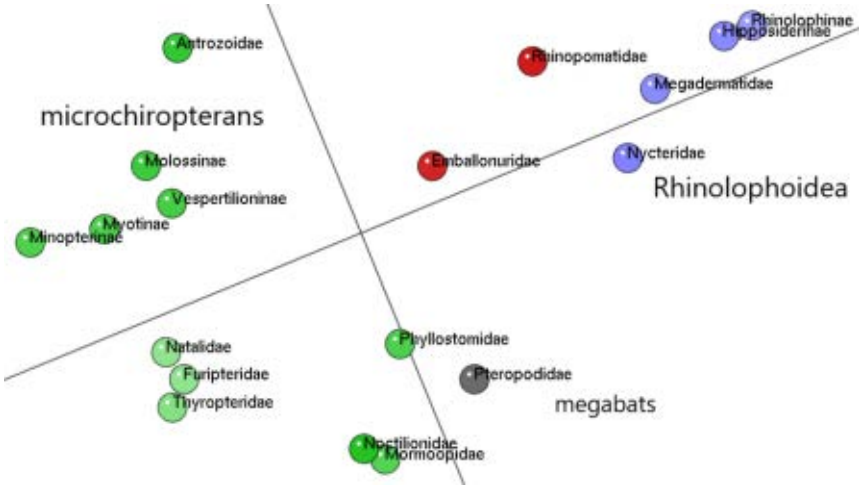

Figure 2. 3D MDS figure of the 30 species in the morphology study. Blue: Rhinolophoidea, green: all other microbats, grey: megabats, red: Rhinopomatidae and Emballonuridae.

Morphological analysis

A morphology data set from Simmons and Geisler was used to do a preliminary morphology-based analysis. This data set contained 208 characters for 28 bat families and subfamilies as well as Scandentia (tree shrews) and Dermoptera (colugos), as outgroups. The data matrix can be found in supplementary file 1. The data set was analyzed using the BDIST software, using a relevance cutoff of 0.95, including 18 of the species after entropy filtering. The results can be seen in figure 1. A stress plot shows a minimal unscaled stress value of 0.061 at seven dimensions (supplementary figure 1). The BDIST correlation graph shows four clusters of species. The differing number of clusters in the correlation graph and the stress plot may be due to distortion in the data.

The first group of four species in the upper right corner of the BDIST graph correspond to a group of species in the superfamily Rhinolophoidea: Nycteridae, Megadermatidae, Rhinolophinae, and Hipposiderinae. These species show discontinuity with species from the fourth group in the graph. Even though they do not show discontinuity with the second and third group, neither do they show continuity with them, either.

The second group consists of a single family, Pteropodidae, the megabats. They show neither continuity nor discontinuity with any of the other three groups.

The third group consists of two families, Rhinopomatidae and Emballonuridae. They show discontinuity with the fourth group but lack continuity with the first and second group.

The last group of 11 species makes up the rest of the microchiropteran species. These include the families Antrozoidae, Furipteridae, Minopterinae, Molossinae, Mormoopidae, Myotinae, Natalidae, Noctilionidae, Phyllostomidae, Thyropteridae, and Vespertilioninae.

Figure 2 shows the 3D MDS plot for the 18 species analyzed in this study. The megabats (Pteropodidae, grey) are alone by themselves at the bottom left of the plot. Four species from Rhinolophoidea can be seen to the left (blue). Rhinopomatidae and Emballonuridae are between the microchiropterans and Rhinolophoidea, similar to the way they are placed between these two groups in figure 1. This way, they appear to form their own group. Although they do not show continuity with these two other groups, neither do they show discontinuity. Thus, their baraminic classification is not completely clear. All other microchiropterans can be seen to the right of the plot in green.

Interpretation of mitochondrial DNA analysis

Besides morphological analysis, two genetic analyses were performed. The first one involved aligning the mtDNA sequences of 130 bat species and clustering them based on global sequence similarity.

The Hopkins statistic for the sequence similarity matrix is 0.905, which means that the data clusters very well. The heatmap of the identity matrix can be seen in figure 3. In this figure, four main groups are visible in dark yellow. From bottom left to top right these groups are the superfamilies Vespertilionoidea, with 42 species, Noctilionoidea, with 31 species, Rhinolophoidea, with 13 species, and Megachiroptera with

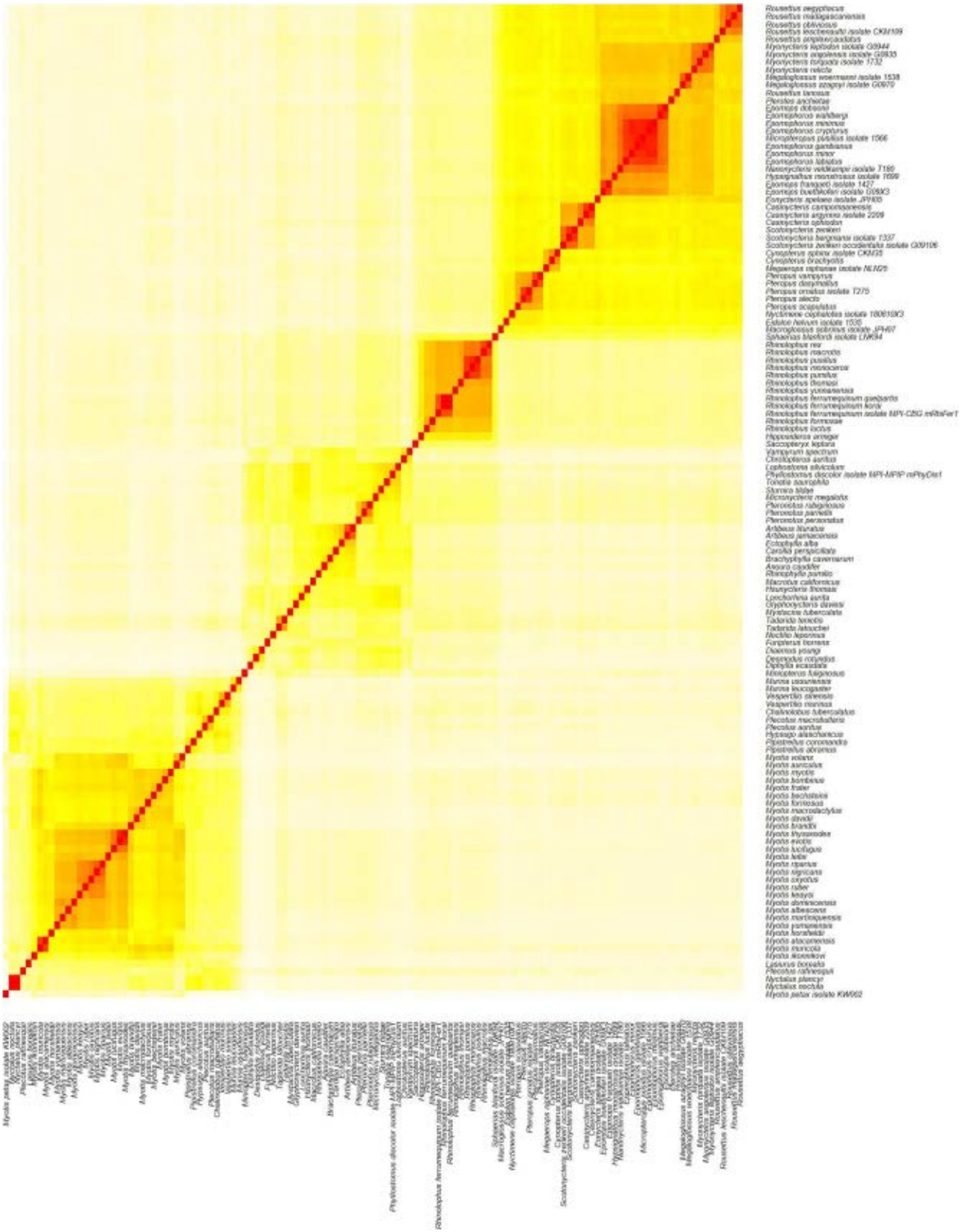

Figure 3. Heatmap of the mitochondrial DNA identity matrix of 130 bat species. Darker, red squares denote higher identity values between two species. Lighter, lemon-coloured squares represent lower identity values.

Table 1. Statistics for four clusters of bats based on the mtDNA analysis

Cluster name	no. species	min	mean	max	st. dev.	p-value
Megachiroptera	44	0.742	0.823	0.986	0.043	0.00E+00
Noctilionoidea	31	0.692	0.757	0.94	0.032	2.22E-151
Vespertilionoidea	42	0.62	0.779	0.994	0.052	2.64E-262
Rhinolophoidea+Emballonuridae	13	0.81	0.875	0.996	0.041	1.69E-49

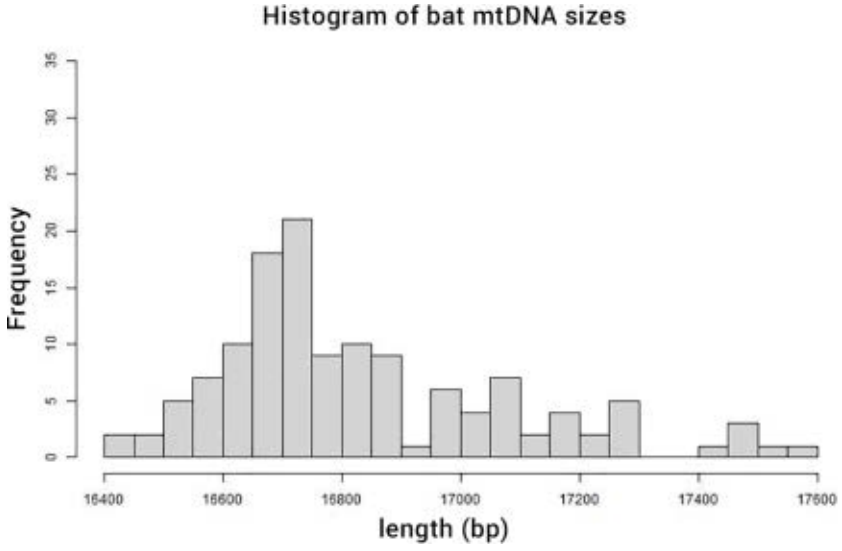

Figure 4. Histogram of mtDNA lengths. The histogram is multimodal which may indicate multiple clusters of species.

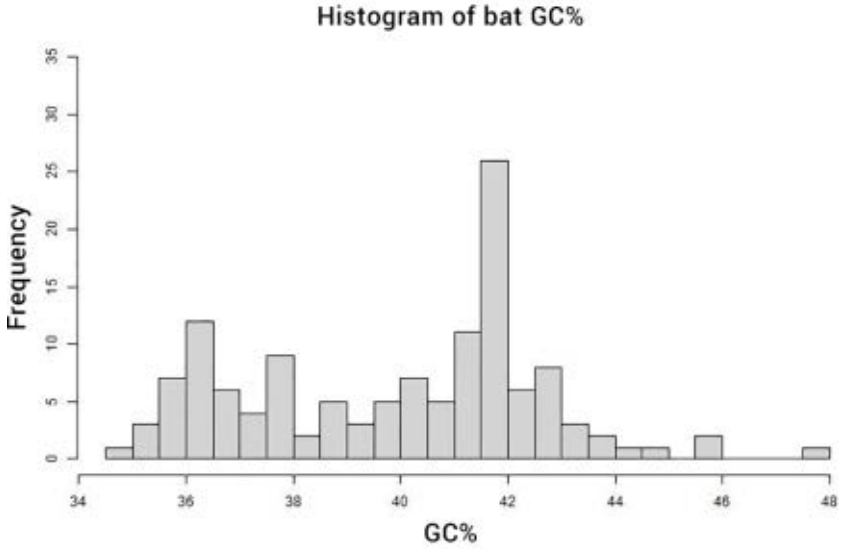

Figure 5. Histogram of GC% values of the mtDNA sequences. The histogram is bimodal, which also indicates at least two clusters of species.

44 species. The classification of these species can be found in Supplementary file 3. Table 1 shows the different statistics for these four groups. The p-value indicates that all four groups are statistically significant.

Besides sequence similarity, several other characteristics of the mtDNA may help us delineate different holobaramins. These include the length of the mtDNA, the order of the genes on the mtDNA, and the GC%. If there are any significant differences in these parameters, this may indicate two or more baramins, which may or may not be holobaramins (apobaramins). The rationale is that living creatures have been in existence for only thousands of years, meaning that the mtDNA remains fairly invariable within holobaramins despite mutations. Hence statistically significant differences must exist between groups. While these methods of looking at general characteristics of the DNA may not yield concrete holobaramins, as a top-down approach they may still break down the species in the data set into smaller groups.

The length of the mtDNA can sometimes be a good indicator of different baramins. The histogram of the lengths of the mtDNA (figure 4) seem to indicate three modes, at 16,700 bp, 17,100 bp, and 17,500 bp, respectively. mtDNA lengths range from 16,415 bp to 17,562 bp, with a mean value of 16,833.9 ± 249.5 bp. However, *Myotis* species also have a wide range of mtDNA lengths, covering multiple modes, from 16,584 bp to 17,562 bp.

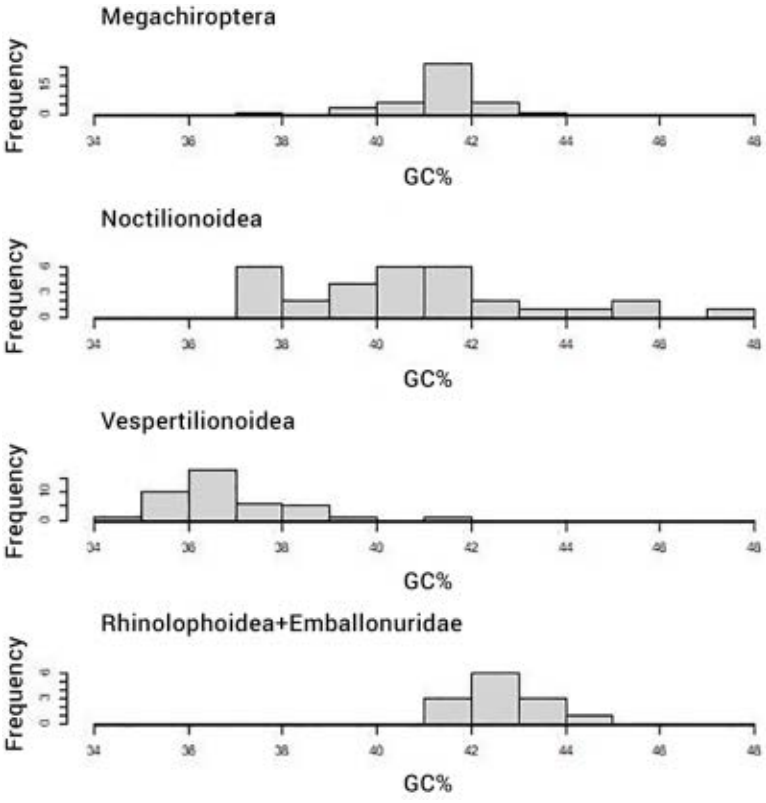

Figure 6. Histograms showing the range of GC% values for each of the four putative baramins: 1 = Megachiroptera; 2 = Noctilionoidea; 3 = Vespertilionoidea; and 4 = Rhinolophoidea.

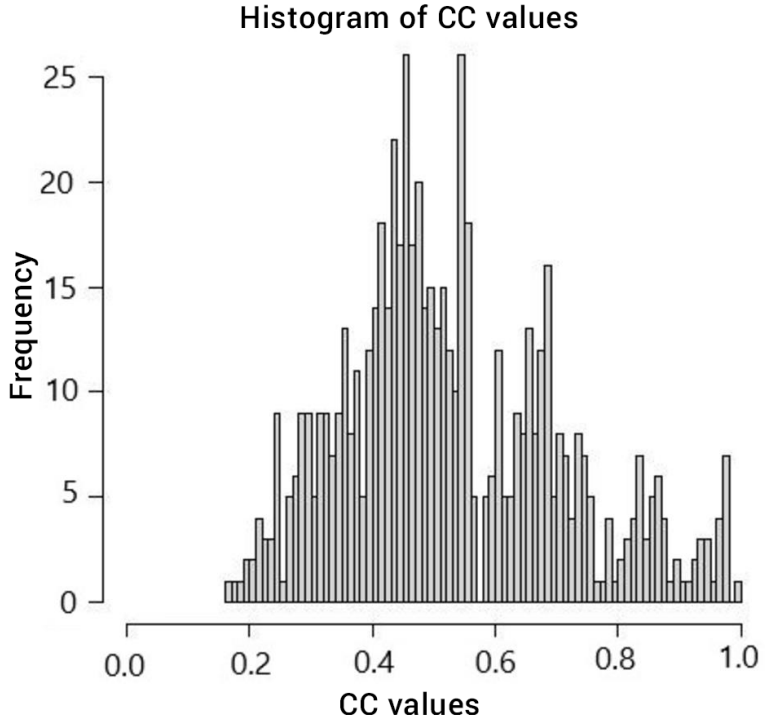

Figure 7. Histogram of the PCC values from the WGKS analysis. The histogram is multimodal which indicates multiple clusters of species.

The gene order of 13 protein-coding genes, 22 tRNA's, 2 rRNA's and the control region seem to be the same for many bat species, based on a study by Lopez-Wilchis *et al.* of five bat species: *Pteronotus personatus*, *Pteronotus parnellii* (two megabats), *Vampyrum spectrum*, *Mystacina tuberculate* (two species from Noctilionoidea), and *Lasiurus borealis* (Vespertilionoidea).[22] Therefore, mitochondrial DNA gene order does not appear to be a good indicator of baraminic relationships between bat groups.

Lastly, GC% ranges from 35 to 47.6%, with a mean value of 39.9 ± 2.72%. The histogram in figure 5 is bimodal, with one mode just over 36% and the second mode just below 42%. Here *Myotis* species are distributed throughout the curve characterized by the first mode, with a range of 35.2% to 38.3%. Figure 6 shows the GC% for each of the four groups. Statistics for these four groups can also be seen in table 2. In figure 6, groups 1 (Megachiroptera), 3 (Vespertilionoidea) and 4 (Rhinolophoidea+Emballonuridae) have GC% values centred around a single mode, with standard deviations around 1.0, whereas group 2 (Noctilionoidea) has GC% values which are fairly spread out (sd=2.53).

Interpretation of WGKS results

The PCC values from the WGKS analysis were plotted in a histogram, showing the density plot above the histogram values (figure 7). It is very interesting to see that within bats, the spread of PCC values is quite broad, with a range of 0.160 to 0.991. The PCC histogram has multiple modes. This is an indication that there could be more than one cluster within the data; another indication that bats are apobaraminic.[23] The Hopkins clustering statistic is 0.817, which indicates a fairly good clustering quality. *Tupaia tana*, the large tree shrew, was selected because it belongs to the order Scandentia, which also served as an outlier species in the morphology study.

The heatmap in figure 8 shows several larger and several smaller groups and some singleton species. The species and their clusters are listed in table 3. Five statistically significant clusters were found; their statistics are

Table 2. Statistics on GC% values for each of the four putative baramins in the mtDNA study

Group	no. species	min	mean	max	st. dev.	p-value
Megachiroptera	44	37.9	41.4	43.5	0.97	0.00E+00
Noctilionoidea	31	37.7	40.9	47.6	2.53	2.22E-151
Vespertilionoidea	42	35	36.8	41.7	1.31	2.64E-262
Rhinolophoidea+Emballonuridae	13	41.1	42.8	44.5	0.91	1.69E-49

shown in table 4. Of these, only three groups had three or more species.

Starting from the bottom left corner we have seven species from the group Vespertilionoidea, otherwise known as common bats. This group includes species from the genera *Aeorestes*, *Antrozous*, *Eptesicus*, *Lasiurus*, *Murina*, *Myotis*, *Nycticeius*, and *Pipistrellus*. In the middle of the heatmap we see seven species of megachiropterans, from the genera *Cynopterus*, *Eidolon*, *Eonycteris*, *Macroglossus*, *Pteropus*, and *Rousettus*. In the upper right corner, there are seven species from the group Noctilionoidea, from the genera *Anoura*, *Artibeus*, *Desmodus*, *Mormoops*, *Phyllostomus*, *Pteronotus*, and *Tonatia*. The outlier species, *Tupaia tana*, is in the very upper right corner.

Three other small groups include three species of noctilionids, *Carollia perspicillata*, *Micronycteris hirsuta*, and *Noctilio leporinus*, although this group is not statistically significant ($p = 0.21$). Another group consists of two *Miniopterus* species. A sixth group, with two species from the genus *Hipposideros*, belong to the larger group Rhinolophoidea.

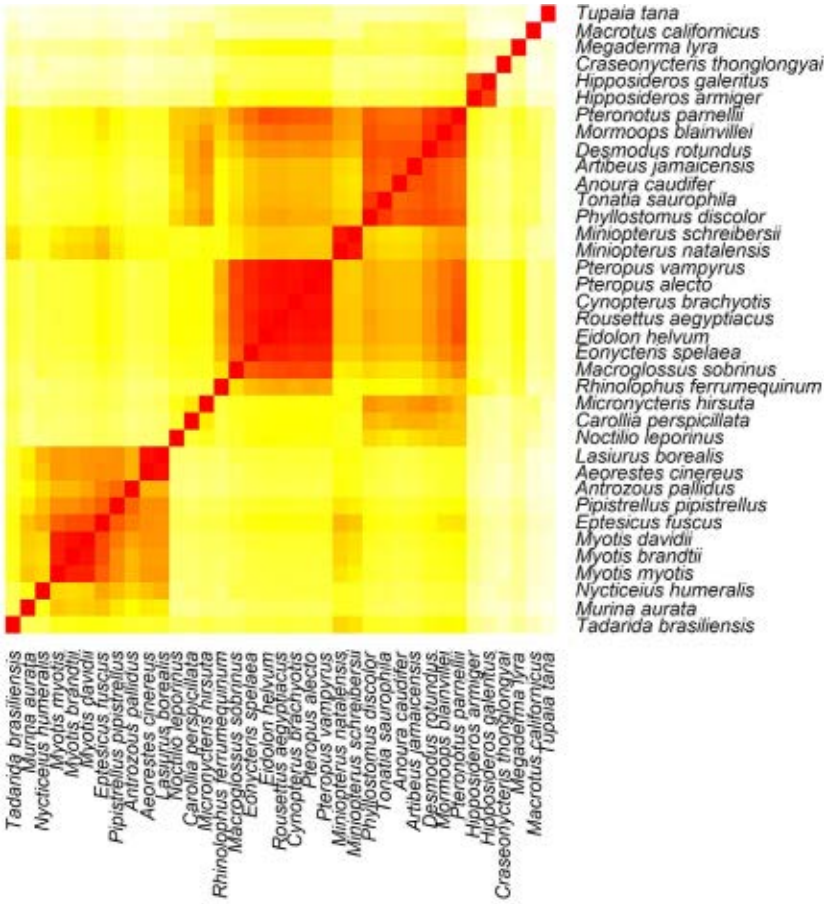

Figure 8. Heatmap of the PCC matrix from the WGKS analysis of 36 bat species and *Tupaia tana* as an outlier. Darker, red squares denote higher identity values between two species. Lighter, yellow-coloured squares represent lower identity values.

These results indicate that there are likely four bat groups, in accordance with the mitochondrial results. However, there might be several noctilionid species, meaning that Noctilionoidea could be an apobaramin.

Discussion

Bats may form multiple baramins, because of discontinuities between different groups based on morphological characters, mtDNA sequence similarities, and Whole Genome K-mer signatures. Intrageneric hybridization occurs between different bat species, but it has not yet been shown to exist between bat families. What is interesting is that Yangochiropteran bats seem to be monophyletic, based on morphology, yet they are split up based on genetic analysis. This highlights the utility of molecular baraminology studies, which can provide additional information to make a more precise, fine-grained determination of the baraminic status of the species under study. It also suggests that God could have created bat species which externally appear to resemble one another, but are somewhat different genetically.

Figure 9. Baraminic tree for each of the four putative baramins. Upper left, Megachiroptera; upper right, Noctilionoidea; lower left, Vespertilionoidea; lower right, Rhinolophoidea.

Different groups of microchiropterans are capable of echolocation, an irreducibly complex design element.[24] Echolocation could possibly be used to separate bat kinds from one another since virtually no megabat species echolocate. The few species that do use their wings to echolocate.

Conversely, even though microchiropterans are nocturnal, they also have functional L opsin and S opsin genes. Many microbats use vision quite well. The microchiropteran *Hipposideros speoris* also responds well to visual signals between 430 and 520 nm, meaning that it may also have M opsins. Since microchiropterans still retain these opsin genes, it is an indication that they didn't always have a nocturnal lifestyle.[25]

There are differences between the results of the molecular baraminology analyses presented here and previous morphology-based estimates by Wood and Lightner. The reason for the discrepancy is likely because Lightner simply drew the baraminic boundary at the family, which is a common way to roughly estimate baramins.[26,27] Wood performed a morphology-based analysis on 64 species of bats from Mormoopidae, Noctilionidae, and Pyllostomidae. Although there was lack of continuity between these bat groups, neither was discontinuity demonstrated between them. Thus, they could be monobaramins within a larger holobaramin. Wood writes: "Future studies could easily rectify either of these problems and thereby clarify the baraminic status of Noctilionoidea."[28]

Figure 9 depicts the baraminic tree for all four putative bat baramins, based on the heatmap for the mtDNA results. Both Noctilionoidea and Vespertilionoidea are superfamilies in Yangochiroptera. Based on an analysis of 812 bat species covering 29 gene loci, the monophyly of these two superfamilies as well as that of Rhinolophoidea were suggested.[29]

Megachiroptera

Megabats form a well-defined baramin, with several monobaramins. These include *Pteropus+Eidolon+Nyctimene+Cynopterus+Megaerops*, *Epomops+Epomophorus+Hypsignathus+Myonycteris+Nanonycteris+Plerotes+Rousettus*, and *Scotonycteris+Casinycteris*. These are all genera of the subfamily Pteropodinae, except for *Macroglossus sobrinus*, and *Sphaerias blanfordi*, which belong to their respective subfamilies.

Megachiropterans differ from microchiropterans in the way nerves between the retina and the midbrain connect.[30] The retinotectal pathway of megabats (such as in *Rousettus aegyptiacus*) is so different from that of microbats, that some researchers think megabats are more similar to primates than microbats. In megabats, both the left and right sides of the tectum are innervated by the corresponding half of the retina of both eyes. In microbats this is different: the left and right halves of both sides of the tectum are innervated by both the left and right halves of the retina of both eyes, respectively.[31] The geographical distribution of megachiropterans

Table 3. Names of species in the WGKS study and their cluster number

species	cluster
Aeorestes cinereus	1
Antrozous pallidus	1
Eptesicus fuscus	1
Lasiurus borealis	1
Murina aurata	1
Myotis brandtii	1
Myotis davidii	1
Myotis myotis	1
Nycticeius humeralis	1
Pipistrellus pipistrellus	1
Anoura caudifer	2
Artibeus jamaicensis	2
Desmodus rotundus	2
Mormoops blainvillei	2
Phyllostomus discolor	2
Pteronotus parnellii	2
Tonatia saurophila	2
Carollia perspicillata	3
Micronycteris hirsuta	3
Noctilio leporinus	3
Craseonycteris thonglongyai	4
Cynopterus brachyotis	5
Eidolon helvum	5
Eonycteris spelaea	5
Macroglossus sobrinus	5
Pteropus alecto	5
Pteropus vampyrus	5
Rousettus aegyptiacus	5
Hipposideros armiger	6
Hipposideros galeritus	6
Macrotus californicus	7
Megaderma lyra	8
Miniopterus natalensis	9
Miniopterus schreibersii	9
Rhinolophus ferrumequinum	10
Tadarida brasiliensis	11
Tupaia tana	12

Table 4. Statistics for bat clusters based on the WGKS method

cluster	species	min	mean	max	stdev	p-value
1	10	0.532	0.726	0.97	0.106	8.90E-26
2	7	0.807	0.853	0.925	0.033	2.53E-48
3	3	0.481	0.534	0.596	0.058	2.31E-01
5	7	0.84	0.934	0.991	0.046	4.77E-36
6	2	0.894	0.894	0.894	NA	4.75E-53
9	2	0.959	0.959	0.959	NA	1.40E-39

is restricted to the Old World, whereas microchiropterans are distributed worldwide.

Noctilionoidea

Noctilionoidea consist of seven families including species which use their nasal passages to emit echolocation calls, and their premaxillaries are also movable compared to their maxillaries.[32] Species belonging to these families are confined mainly to the Neotropics.[33,34]

Based on a study of 12S, 16S rRNA, and $tRNA^{Val}$ sequences in the mitochondrial DNA, Van Den Bussche *et al.* found that Noctilionoidea+Furipteridae+Thyropteridae+Mystacinidae form a monophyletic group.[35] In accordance with previous results of other researchers, the Vampyrini monobaramin (*Vampyrum+Chrotopterus*) was also found to be a part of Noctilionoidea.[36] The family Pyllostomidae forms a large part of the baraminic tree in the upper right portion of figure 9. Besides Pyllostomidae, three *Pteronotus* species come from the family Mormoopidae, *Noctilio leporinus* represents the family Noctilionidae, *Mystacina tuberculata* represents the family Mystacidae, two *Tadarida* species represent the family Molossidae, and the species *Saccopteryx tildae* represents the family Emballonuridae.

Miniopterus fuliginosus is classified as a member of the family Vespertilionidae, so why does it appear within Noctilionoidea? Previous research has shown that bat species in this genus differ from other members of Vespertilionoidea in their morphology, embryology, immunology, and also genetics. Some classify this genus as its own family, and it appears that genetically, it belongs to Noctilionoidea.[37]

Vespertilionoidea

All 42 species in the lower left part of figure 9 come from the family Vespertilionidae, one of the five families of the superfamily Vespertilionoidea. The genus *Myotis* forms a large monobaramin with 28 species. The genera *Pipistrellus*, *Nyctalus*, *Vespertilio*, *Murina*, and *Plecotus* also form several monobaramins.

Rhinolophoidea

The superfamily Rhinolophoidea in the lower right of figure 9 is made up of 12 species of *Rhinolophus* and also *Hipposideros armiger*. These bats are classified by high-duty cycle nasal echolocation, an ossified first cartilage, which is fused to their manubrium and first rib and a pair of pubic nipples in the females, as opposed to all other bats.[38] Many secular studies classify Emballonuroidea as its own superfamily. This group clusters with the megabats in figure 1, but together with Rhinolophoidea in figures 2 and 3.

Conclusion

There appear to be four bat baramins, based on the mutually supporting clustering results of the mtDNA analysis. The four groups are: Megachiroptera, Rhinolophoidea+Emballonuridae, Vespertilionoidea, and Noctilionoidea. However, the WGKS results suggest that Noctilionoidea might be an apobaramin. This indicates that the level of the baramin is at the superfamily level in bats. However, more study is needed to validate these results, such as hybridization studies between species within the four putative baramins delineated here. Molecular results provided better resolution of the species and were able to predict the superfamily Vespertilionoidea and the suborder Megachiroptera. The status of Emballonuroidea still needs further examination, as not too many representative species were studied here. It may be possible that this group forms its own holobaramin.

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